

Using satellite observations to monitor long-term changes in air quality in cities



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defra

Department for Environment
Food and Rural Affairs



Birmingham City Council



London Air

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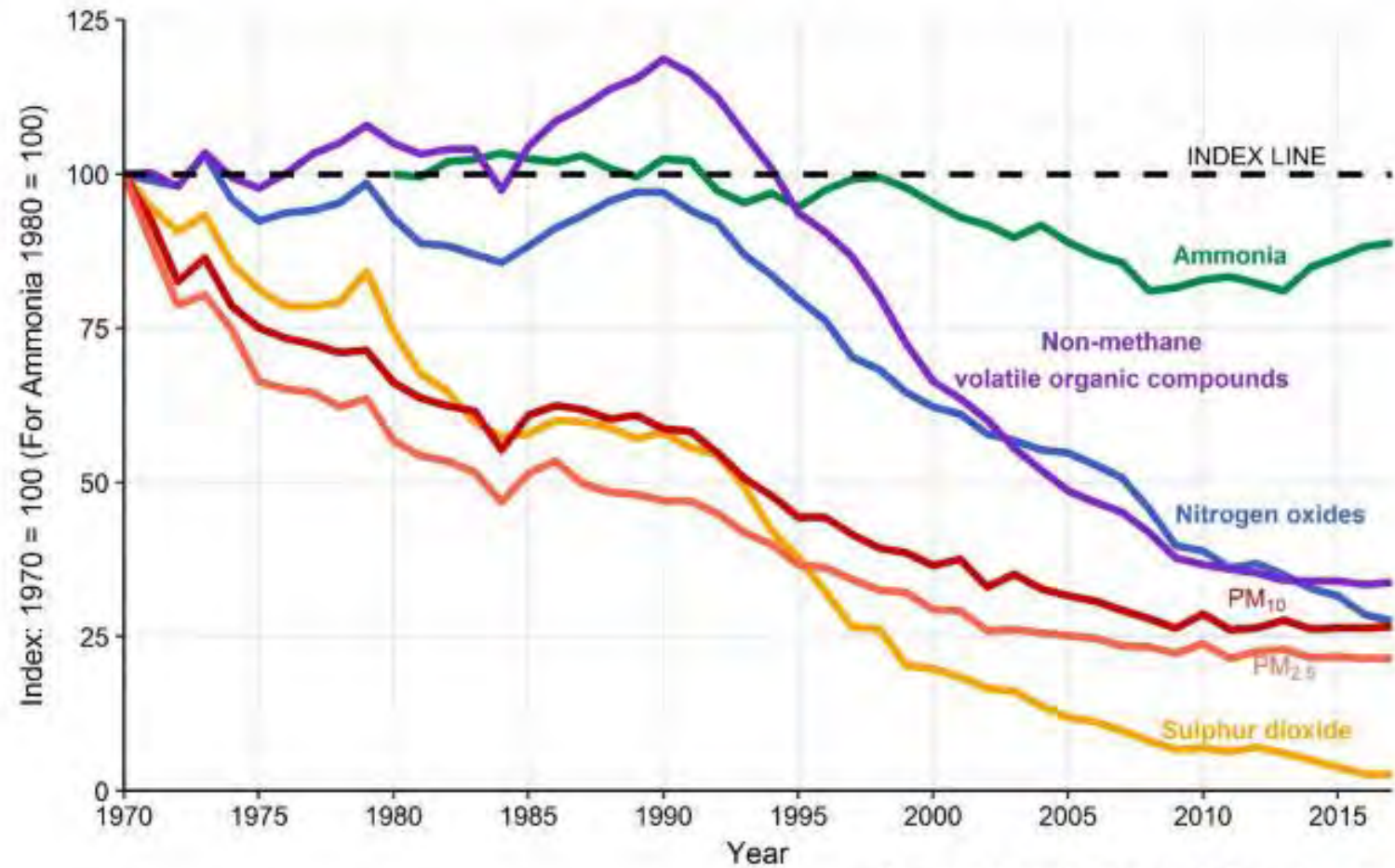
kxv745@student.bham.ac.uk

GEES DR conference (8th May'19)

Courtesy – Library of Birmingham

What do these emission trends tell us?

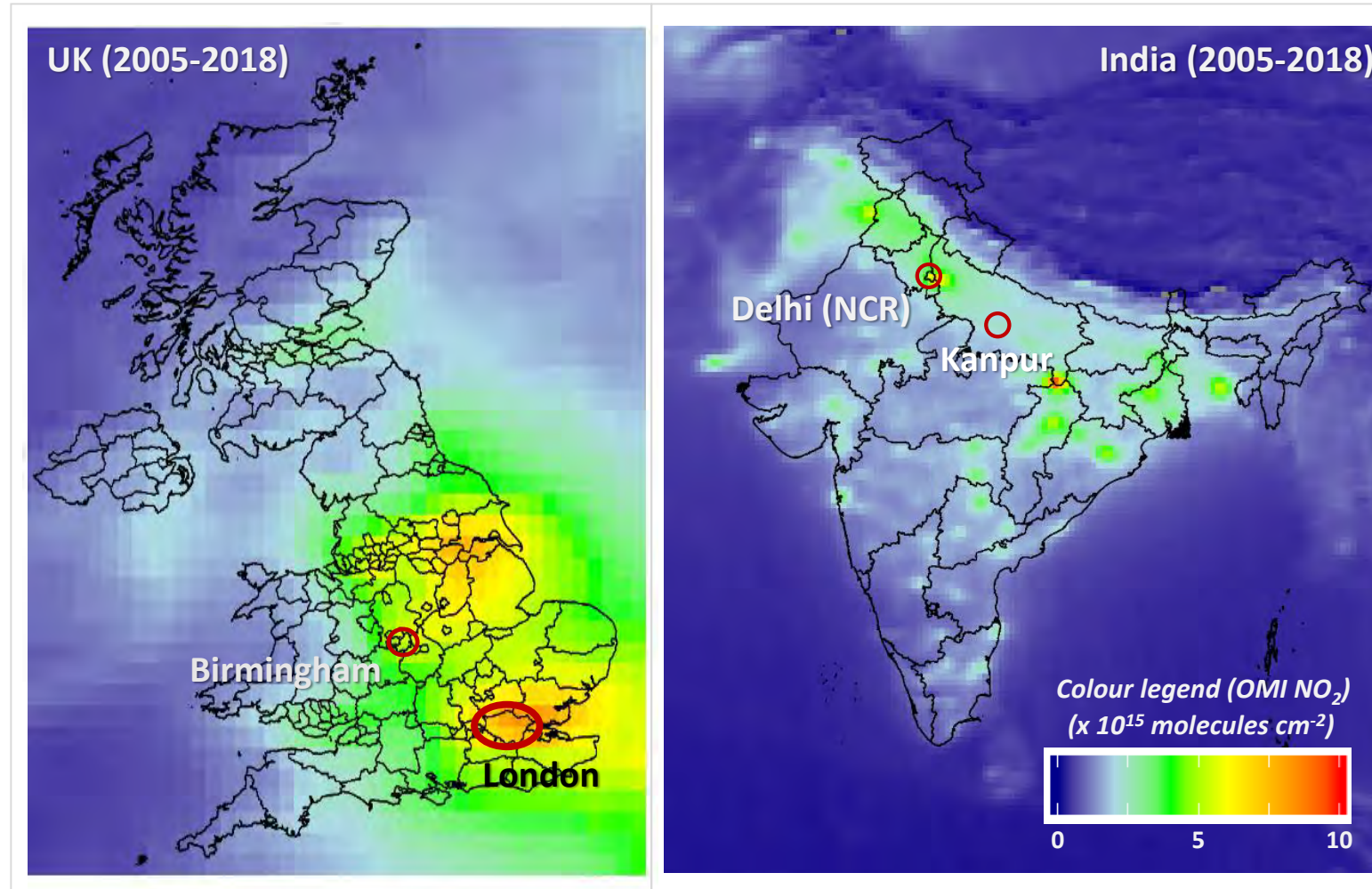
Figure 1: Trends in annual emissions of sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds, ammonia and particulate matter (PM₁₀, PM_{2.5}) in the UK: 1970 – 2017



Source: Ricardo Energy & Environment

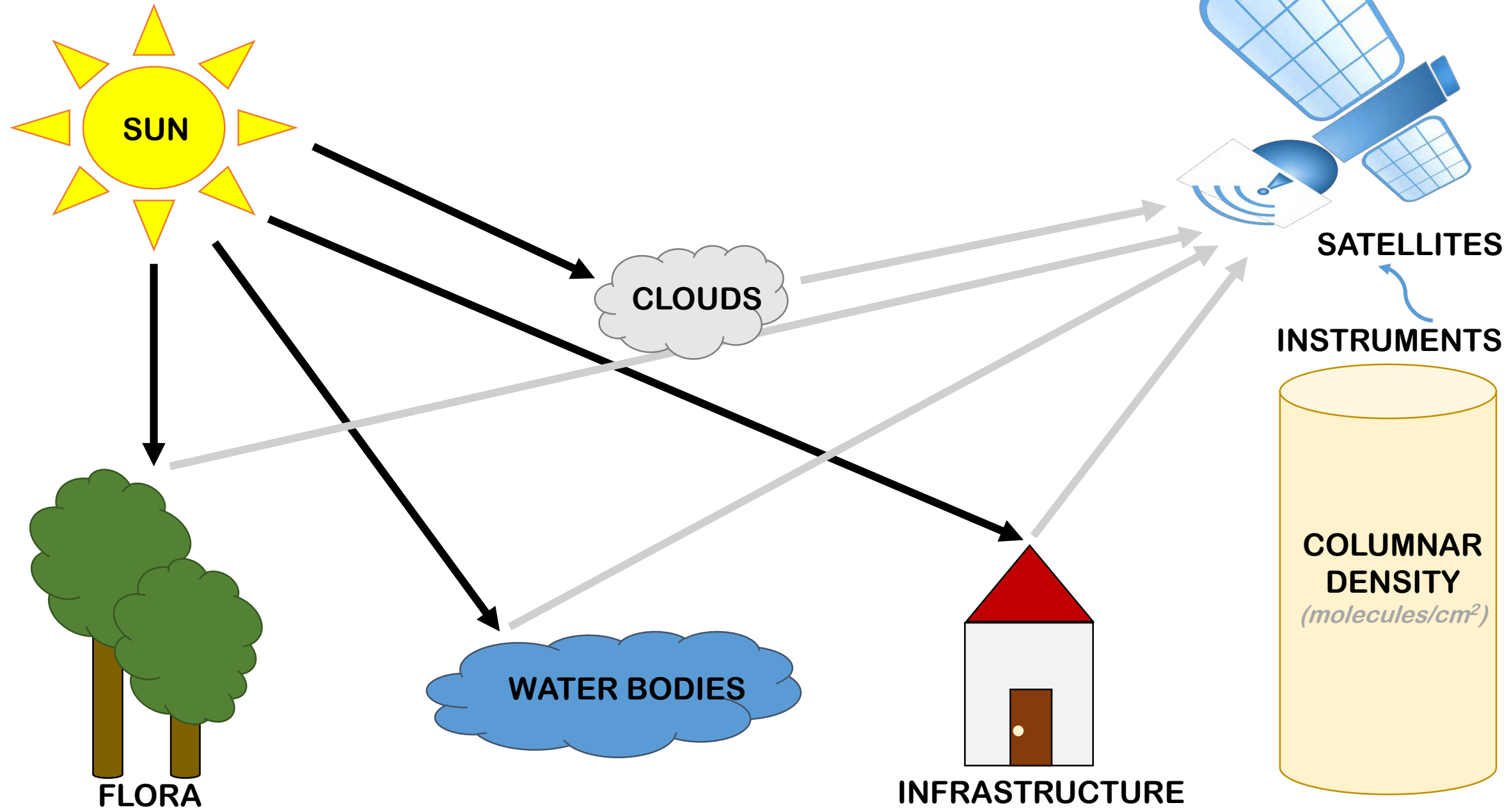
The index line is a comparator that shows the level of emissions if they had remained constant from the beginning of the time series.

Target cities in the UK and India

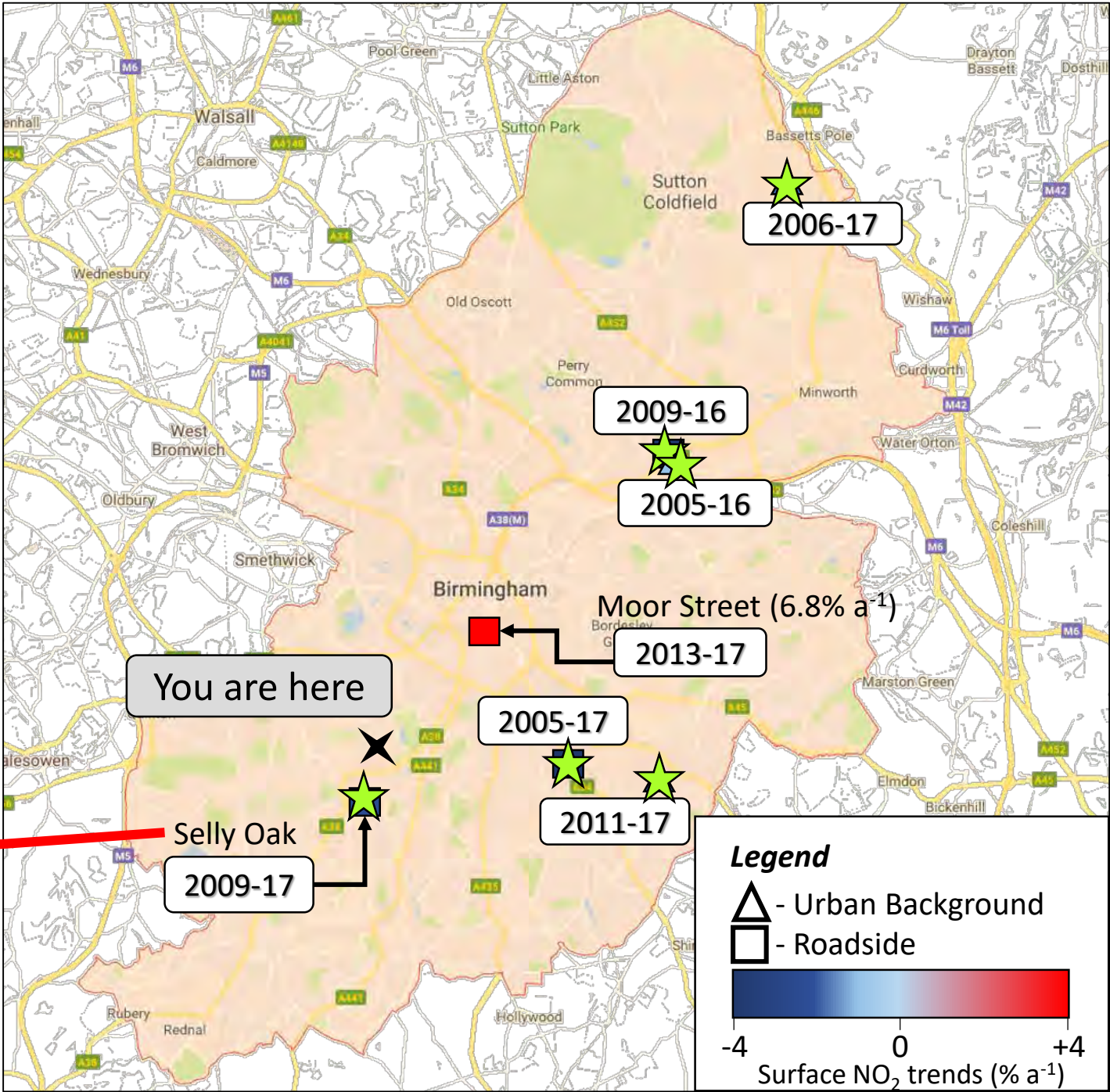


Why satellite observations?

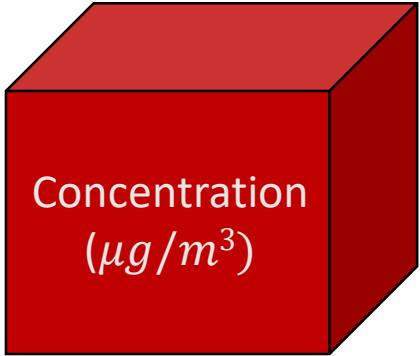
How do satellites collect data?



Surface NO₂ monitoring sites in Birmingham

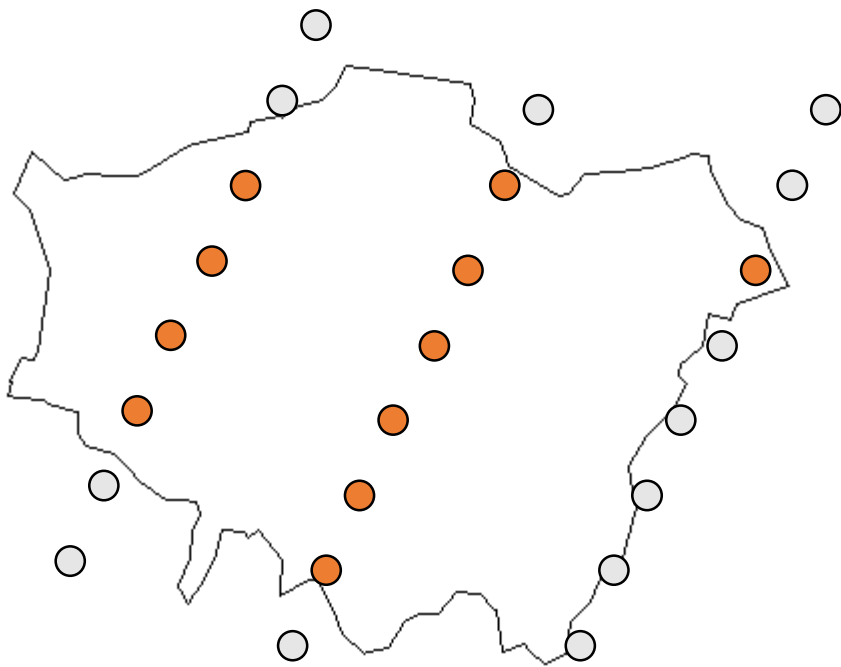


6 sites considered
(Mar'11-Sep'16)

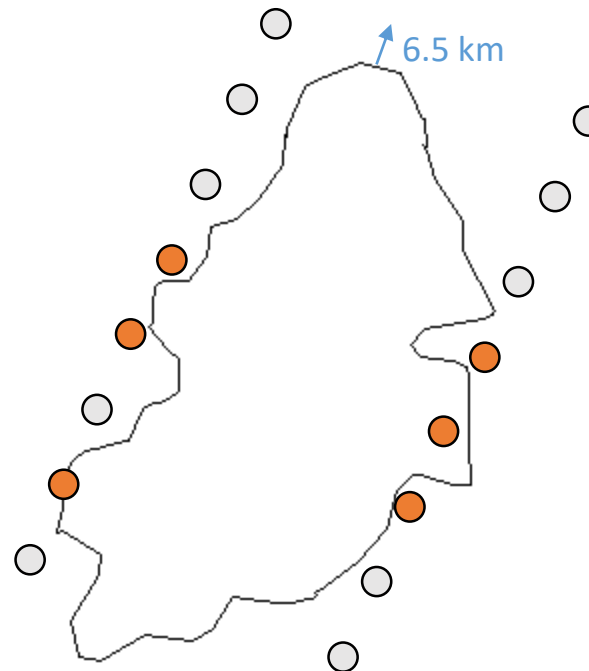


Evaluation of satellite-based NO₂?

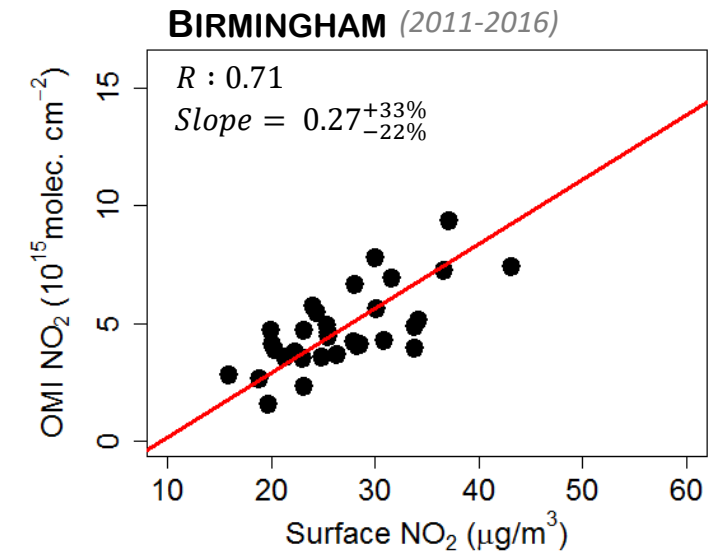
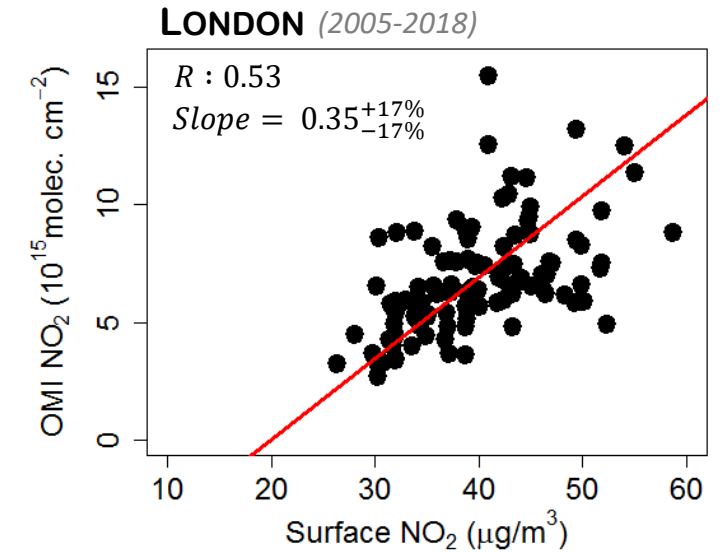
Pollutant	NO ₂
Satellite	NASA Aura
Instrument	Ozone Monitoring Instrument (OMI)
Ground resolution	13 km x 24 km
Overpass time	1330 local time



LONDON (Area – 1569 km²)



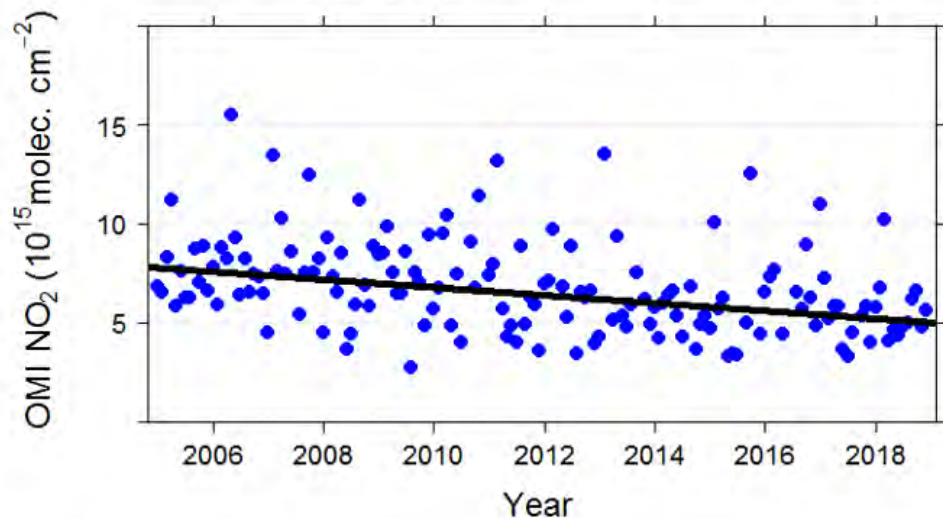
BIRMINGHAM (Area – 268 km²)



Trends in satellite-based NO₂?

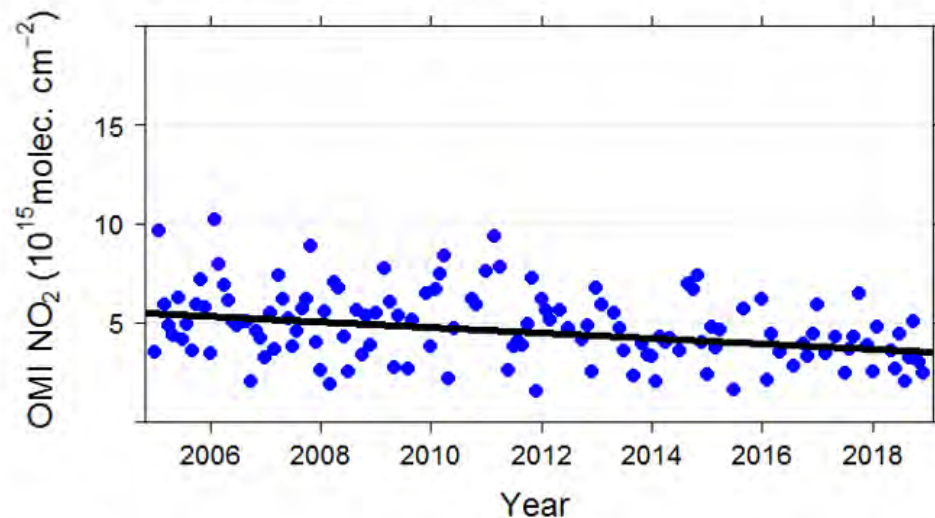
LONDON

Trend = $-2.5^{+28\%}_{-28\%}$ %/year



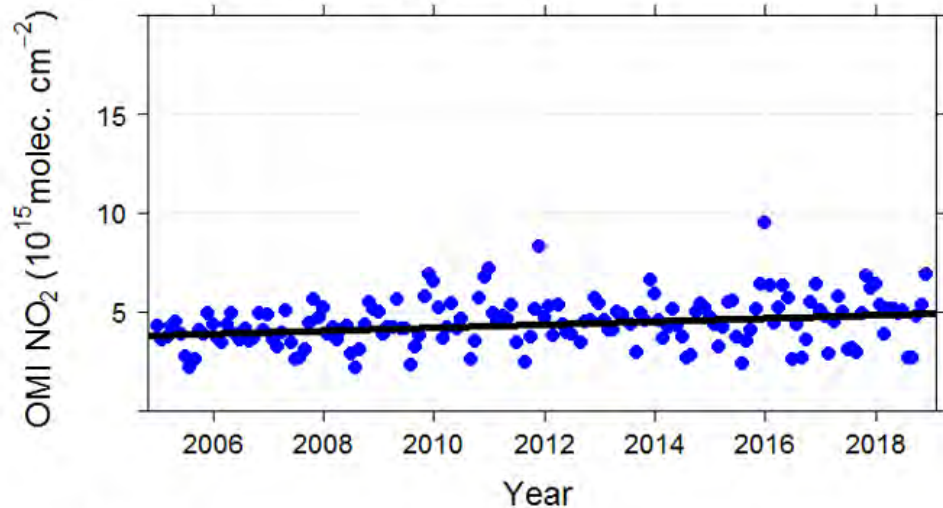
BIRMINGHAM

Trend = $-2.5^{+36\%}_{-36\%}$ %/year



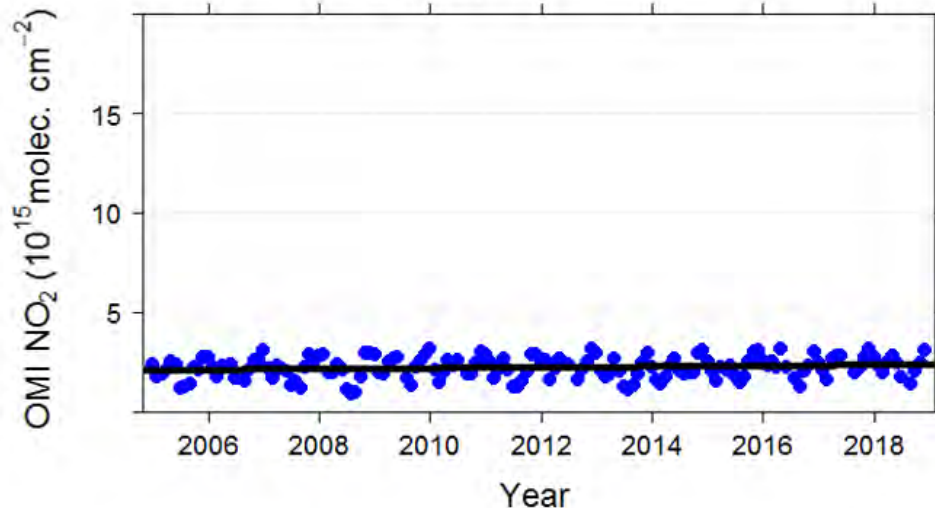
DELHI

Trend = $+2.0^{+65\%}_{-55\%}$ %/year



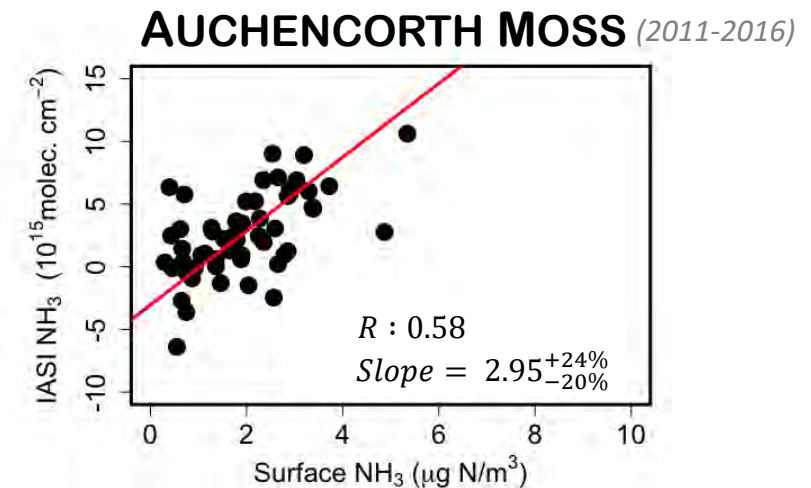
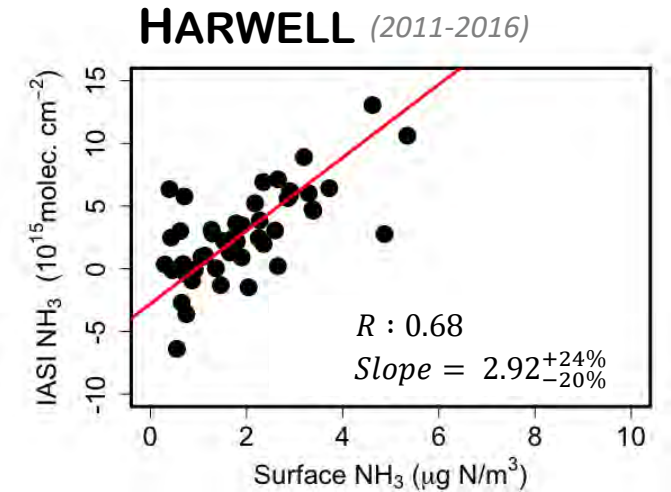
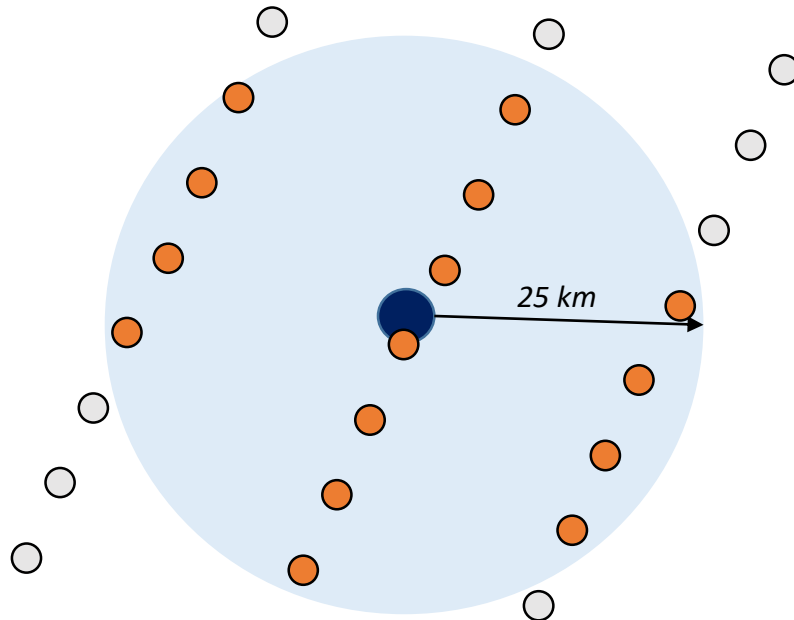
KANPUR

Trend = $+0.9^{+122\%}_{-100\%}$ %/year



Evaluation of satellite-based NH_3 ?

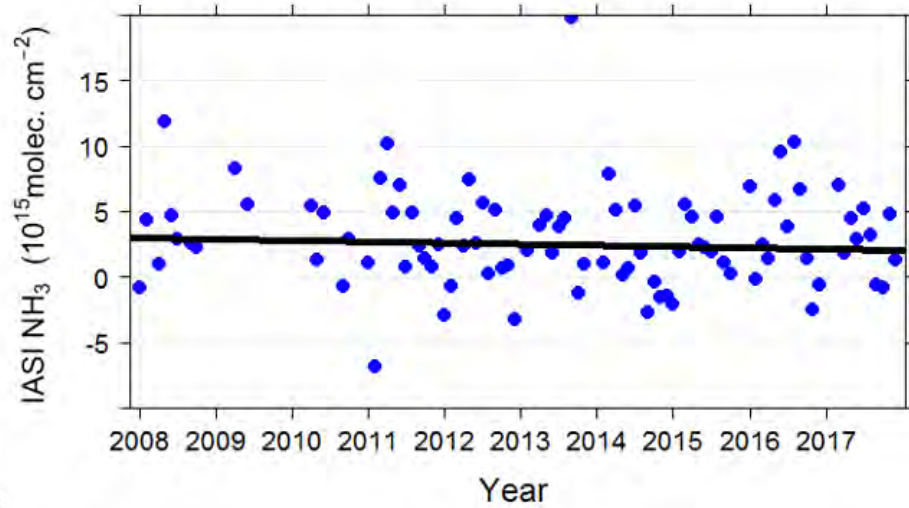
Pollutant	NH_3
Satellite	MetOp - A
Instrument	Infrared Atmospheric Sounding Interferometer (IASI)
Ground resolution	12 km diameter
Overpass time	0930 and 2130 local time



Trends in satellite-based NH_3 ?

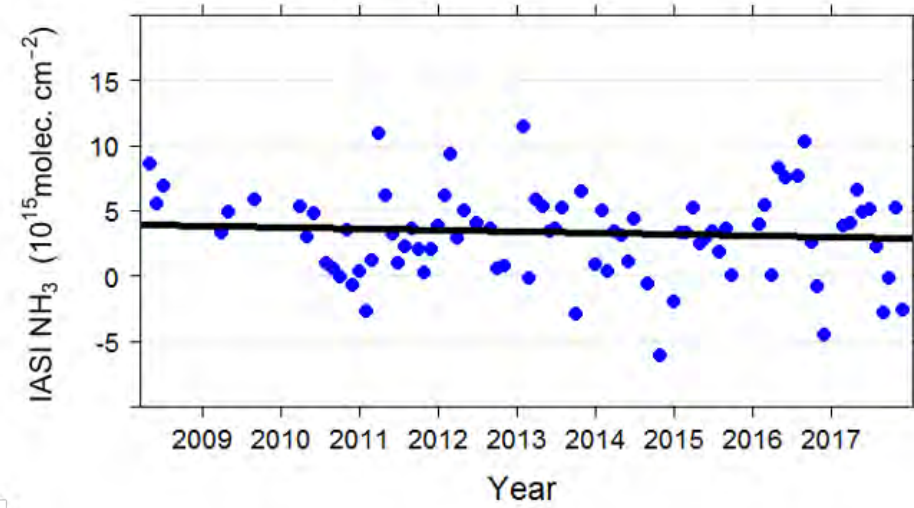
LONDON

Trend = -3% /year



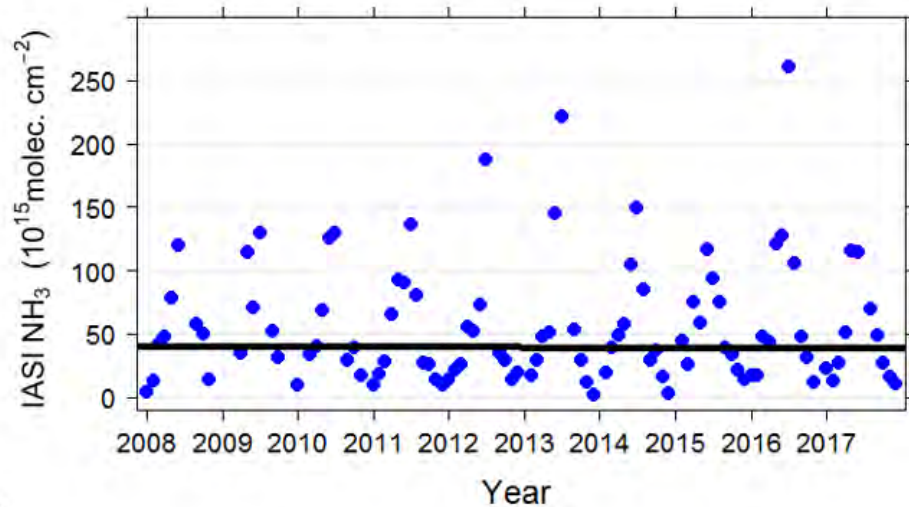
BIRMINGHAM

Trend = -2.8% /year



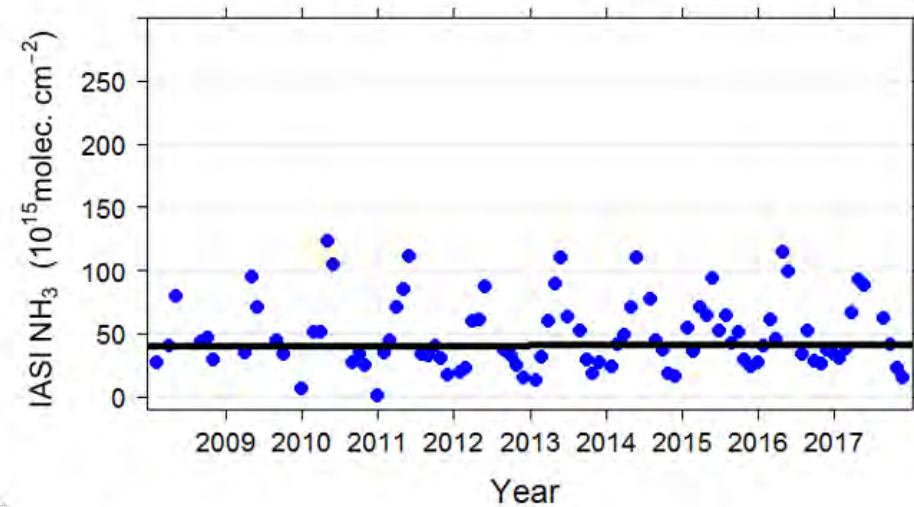
DELHI

Trend = -0.2% /year



KANPUR

Trend = $+0.3\%$ /year



Key Takeaways

- Consistent satellite and ground-based NO_2 and NH_3 give us confidence to apply satellite observations to monitor air quality in cities
- OMI NO_2 declined by 35% in both London and Birmingham from 2005 to 2018 while it has increased by 28% over Delhi and by 12% over Kanpur
- IASI NH_3 shows no significant trend over the 4 target cities

Next Steps

- Evaluate satellite data over **New Delhi** and **Kanpur** for NO_2 and NH_3
- Apply the same approach to other pollutants:
 SO_2 , formaldehyde, CO
- Validate Defra air quality monitoring tools