Tool for Recording and Assessing the City Environment

Engineering and Physical Sciences Research Council

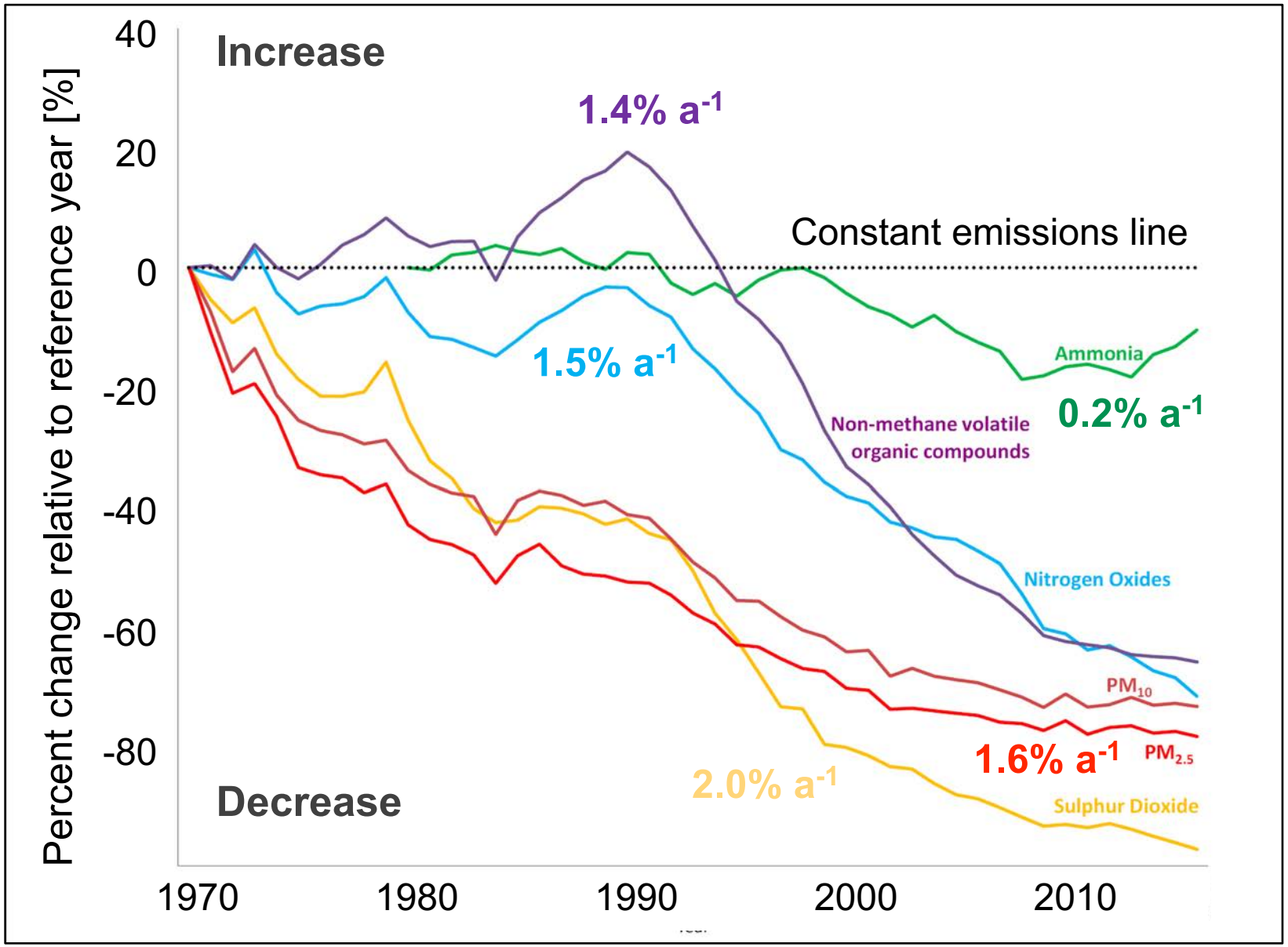
UNIVERSITY OF LEICESTER

Natural Environment Research Council

TRACE

RiR Event **Eloise A Marais** **15 June 2020**

Trends in UK Emissions of Pollutants and Precursors



Values are trends from the start of the record to 2016.

Emissions estimated in a bottom-up approach (relevant activities and emission factors)

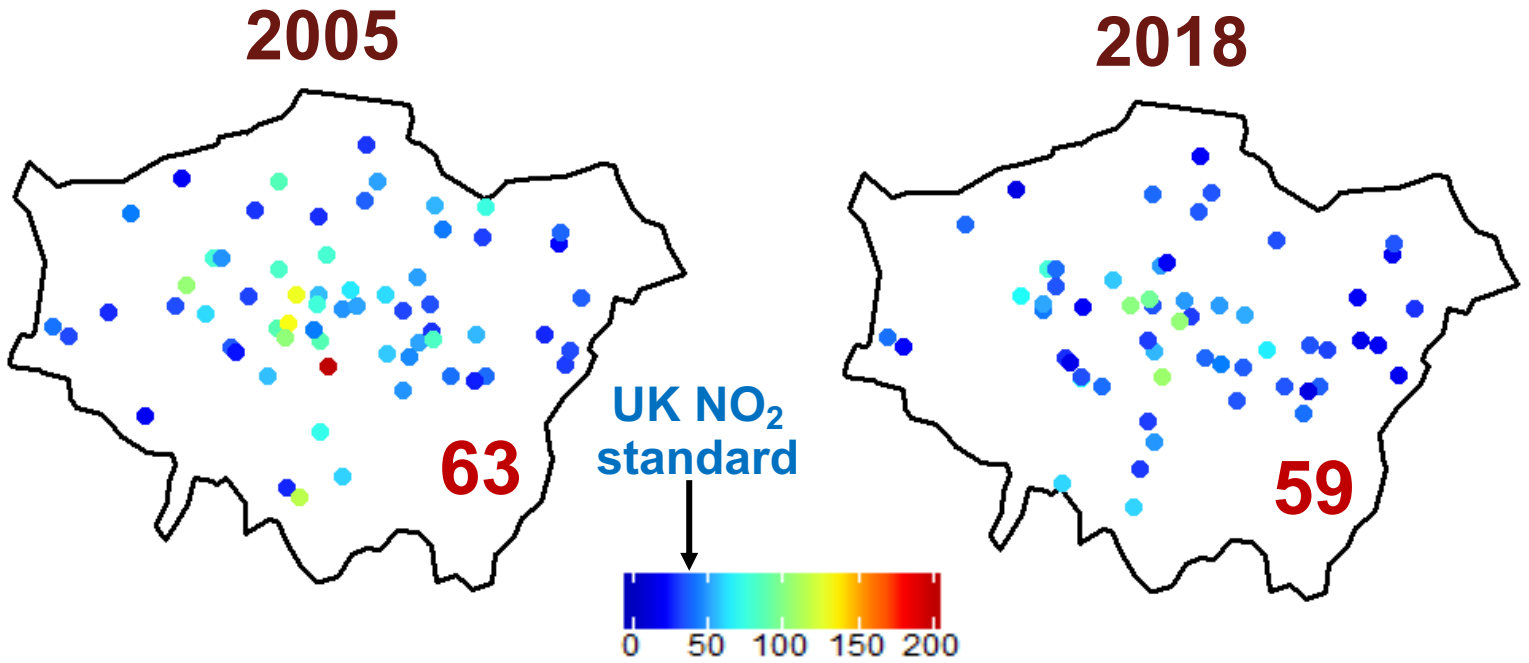
Are these accurate?

How are emissions changing in cities?

[Defra, 2018]

Surface Monitors are Sparse and Inconsistent
Satellites Offer Complete, Consistent Coverage

London Air Quality Network (LAQN) NO_2

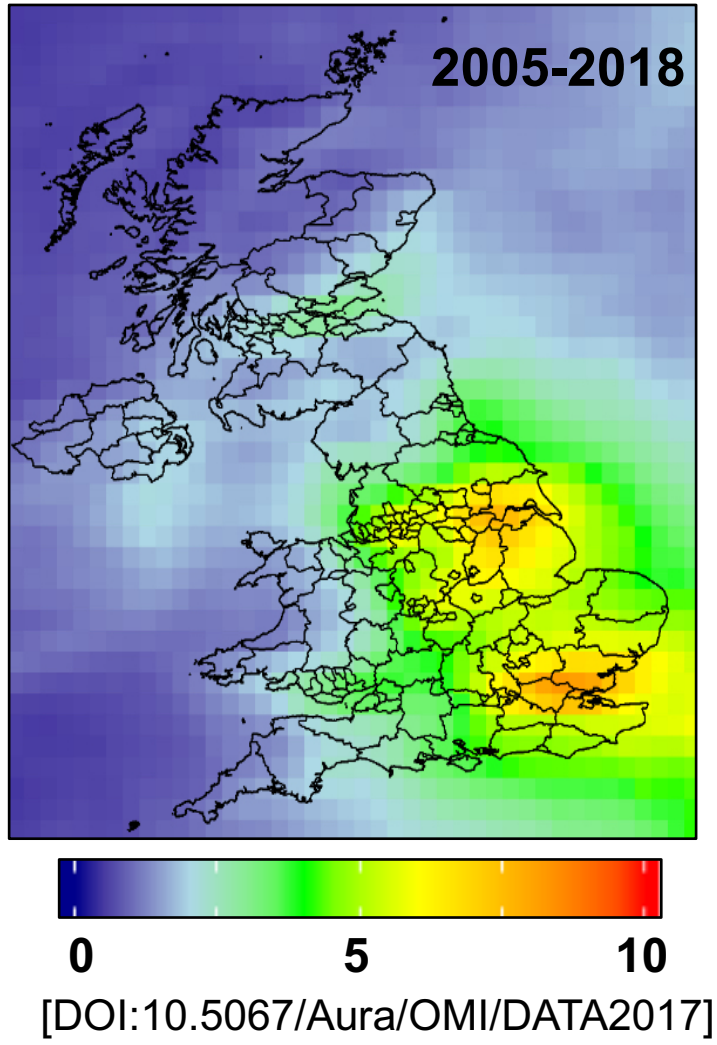


London is likely the most widely monitored city in the world

[https://www.londonair.org.uk/london/asp/datadownload.asp]

Satellite NO_2

[10^{15} molecules cm^{-2}]



[DOI:10.5067/Aura/OMI/DATA2017]

Air Pollutants Impact Health and Vegetation

Food security

O_3

Human health

$PM_{2.5}$

These are Emitted or Formed Physically or Chemically

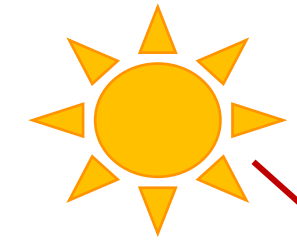
NMVOCs

SO_X

NO_X

NH_3

Primary particles



O_3

Food security

$PM_{2.5}$

Human health

Satellites Monitor Many Air Pollutants and Precursors

NMVOCs

Intermediate product

OMI

HCHO

O_3

Food security

OMI

SO_X

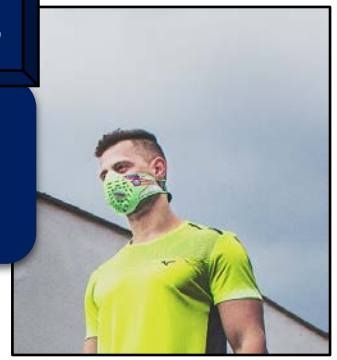
NO_X

OMI

MODIS

$PM_{2.5}$

Human health



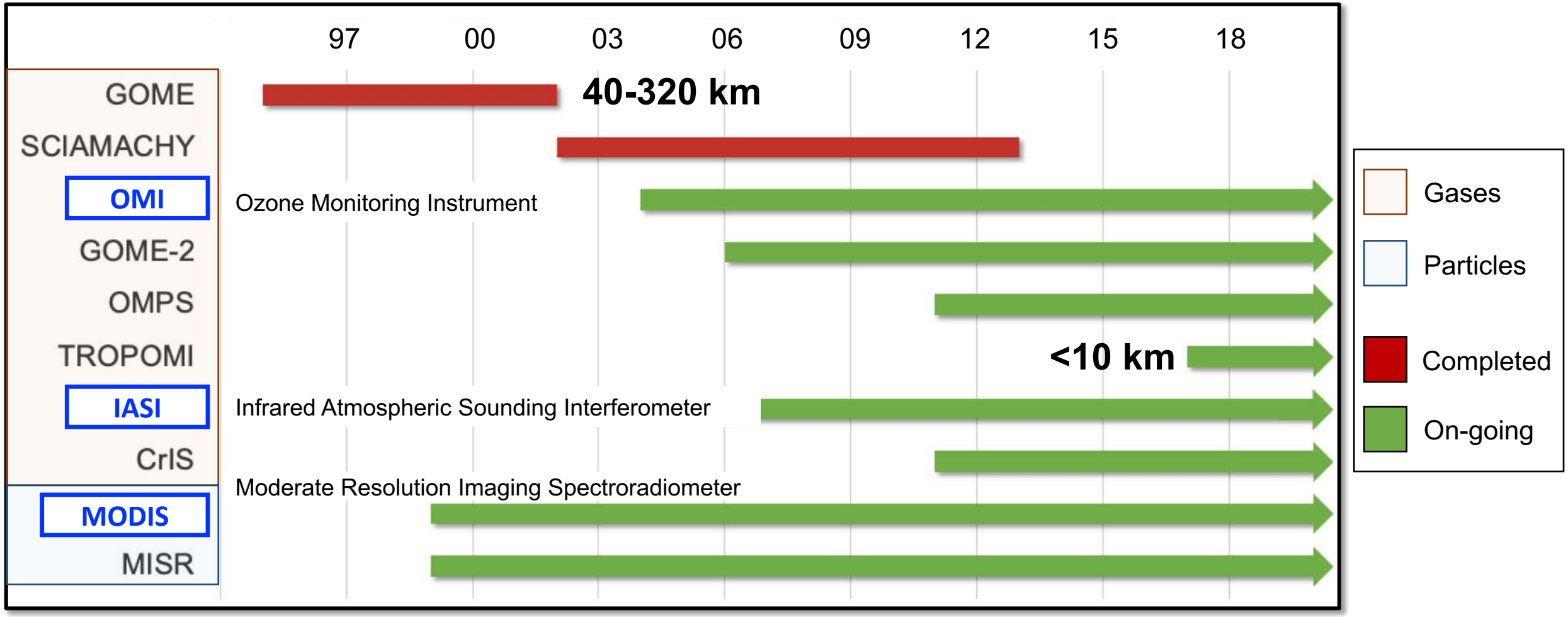
NH_3

IASI

Primary particles

The Satellite Record Extends to the Mid-1990s

Instruments we use



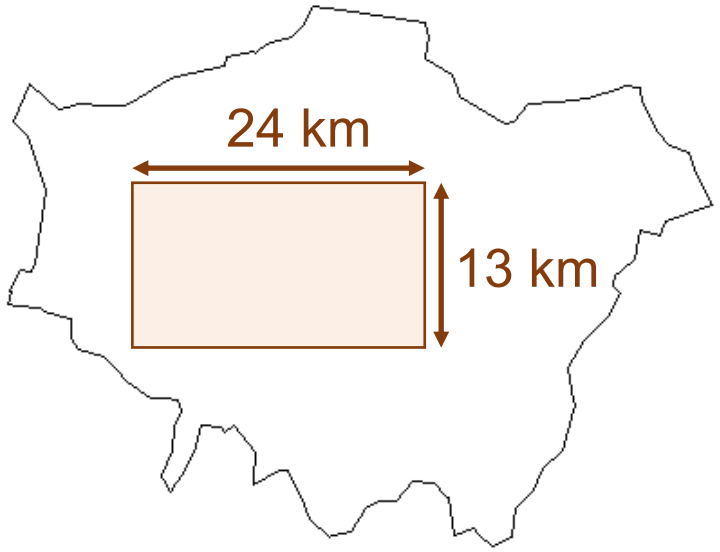
Measurements are at Coarse Spatial Resolution

Individual satellite pixels cover large swaths of a city

OMI

Ozone Monitoring Instrument

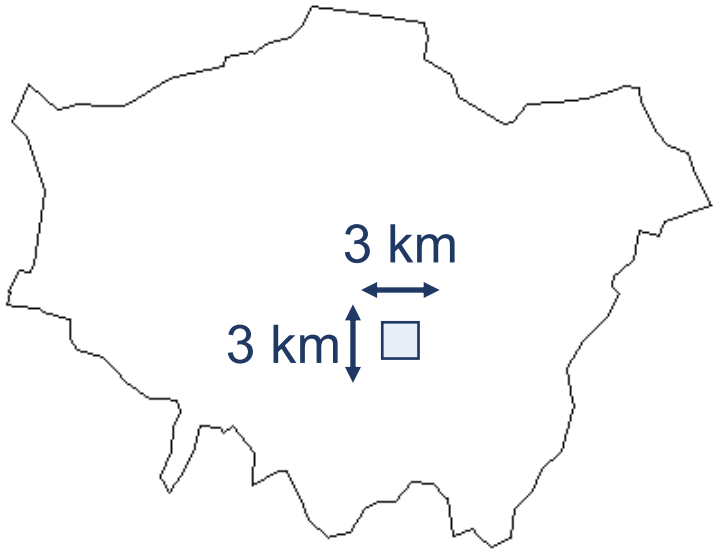
(**NO_2, HCHO**)



MODIS

Moderate Resolution Imaging Spectroradiometer

(**AOD**)



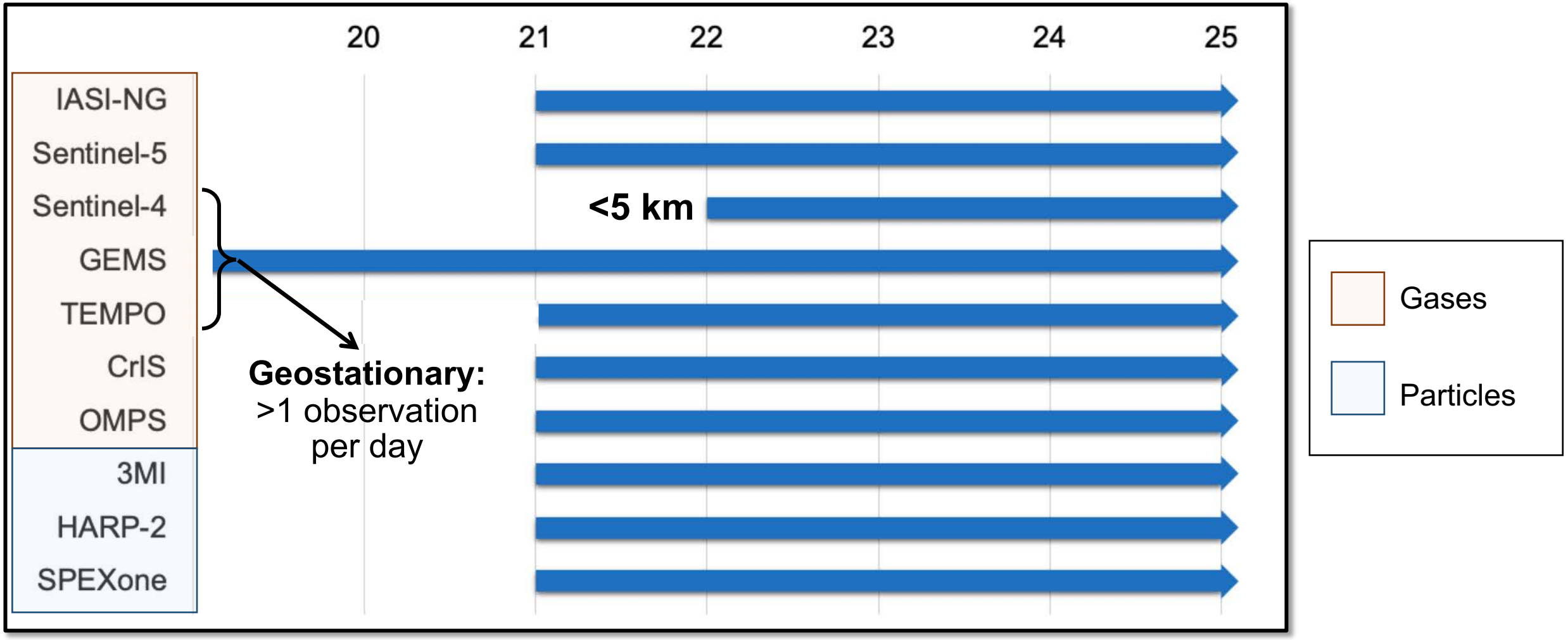
London

(1600 km^2)

IASI: 12 km (not shown)

Limited ability to determine sub-city variability

Spatial Resolution is Improving and the Record is Sustained

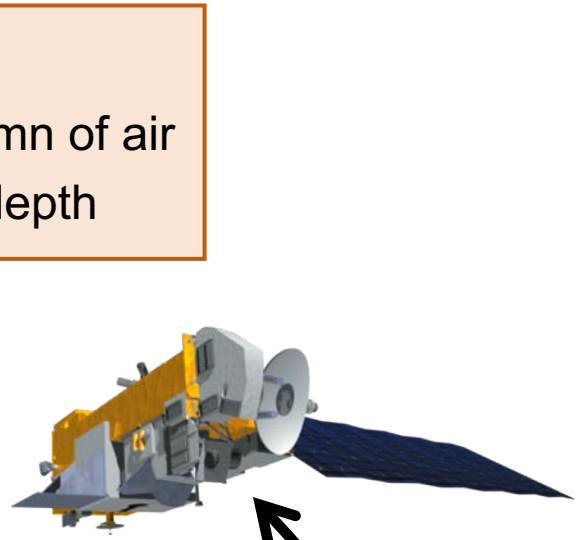


Satellites Measure Solar Backscattered Light Through the Whole Atmospheric Column

Measured quantities

Gases: Molecules in a column of air

Aerosols: Unitless optical depth



Pollution layer (1-2 km)

Troposphere layer
> 10 km

Quality Assure Against Reliable Surface Observations

Component	Completed	Passed
NO_2	✓	✓
NH_3	✓	✓
SO_2	✓	✗
AOD ($PM_{2.5}$)	✓	✓
HCHO (NMVOCs)	—	—

SO_2: poor detection, only sees large sources (unregulated coal-fired power plants)

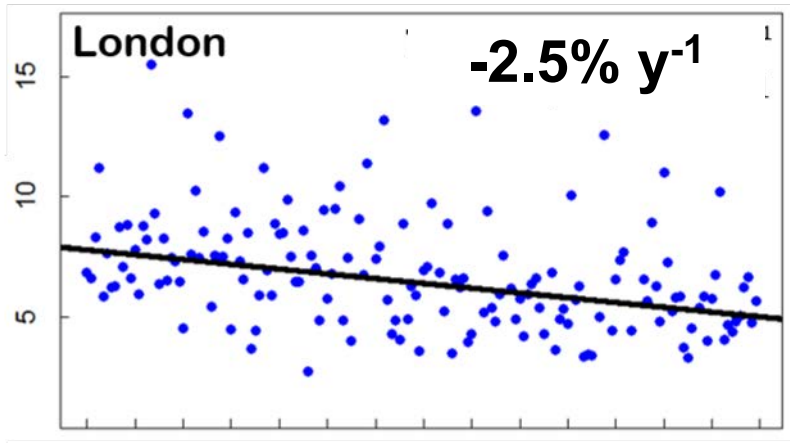
Formaldehyde (**HCHO**): no suitable surface observations

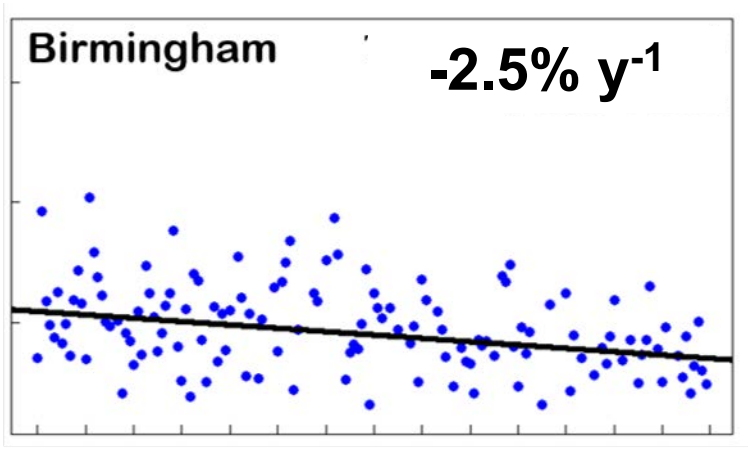
Estimate Trends and Statistical Significance

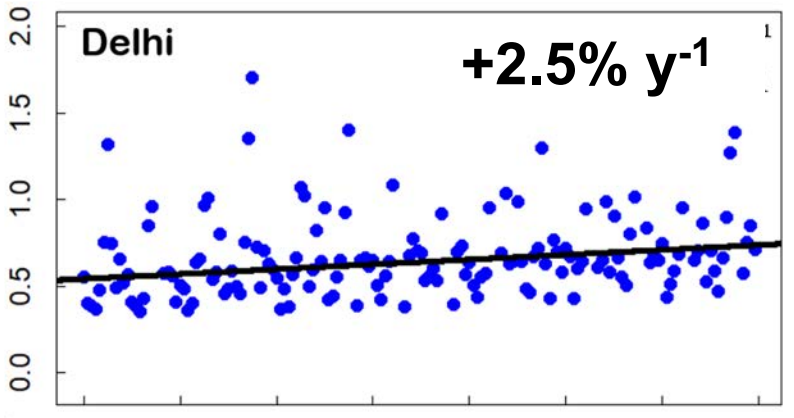
Apply trend analysis to long-term record of satellite observations in cities in the UK and India

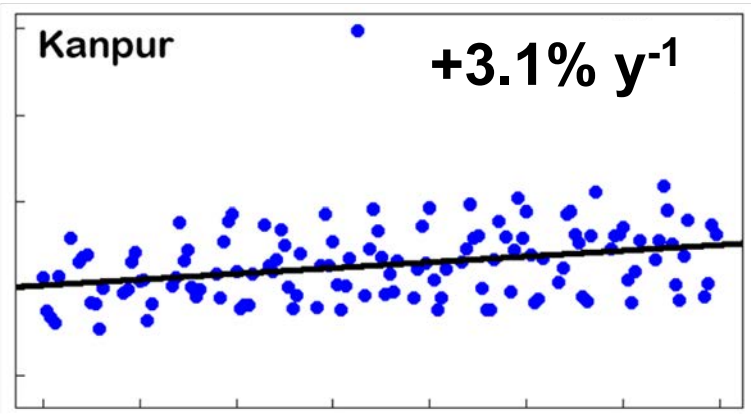
NO_2
[10^{15} molecules cm^{-2}]
2005-2018

AOD
[unitless]
2005-2018
Proxy for $PM_{2.5}$



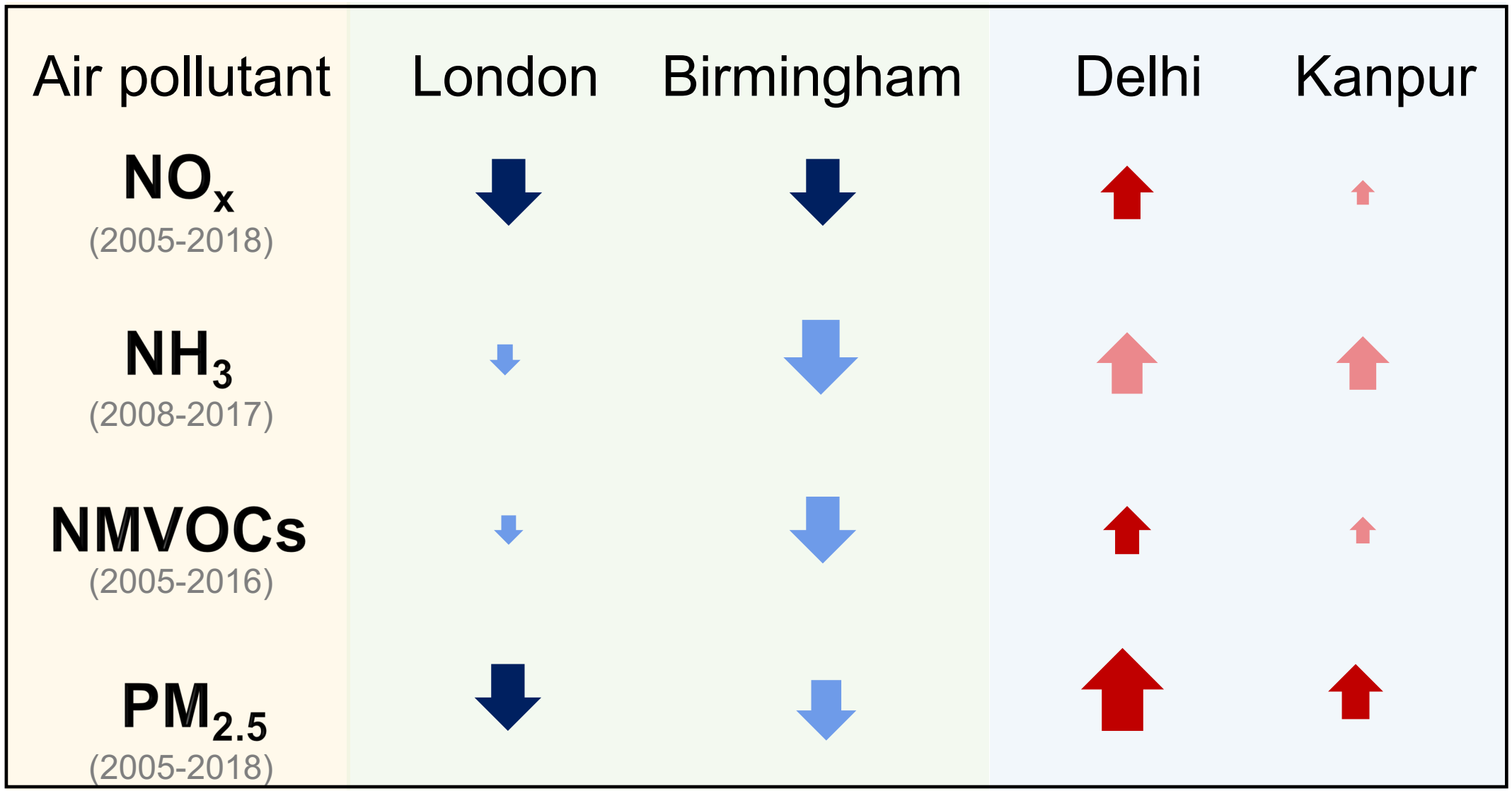


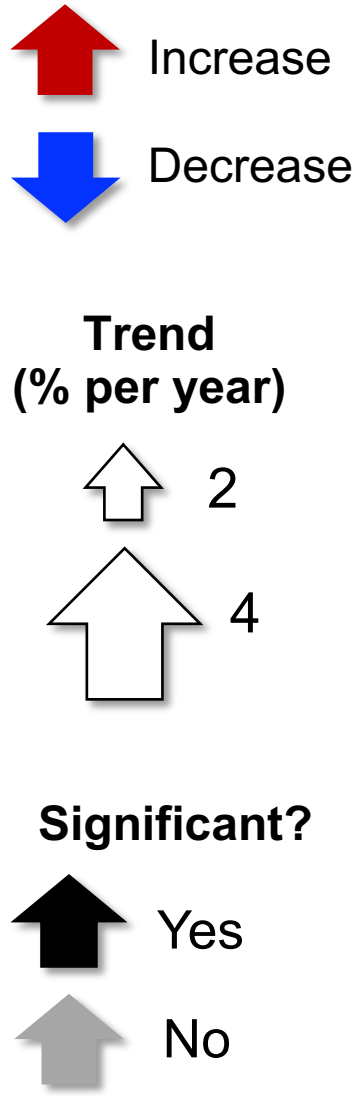




These provide information about the effect of policies or development in their absence on air pollution across a city

Results of Trend and Statistical Significance Analysis

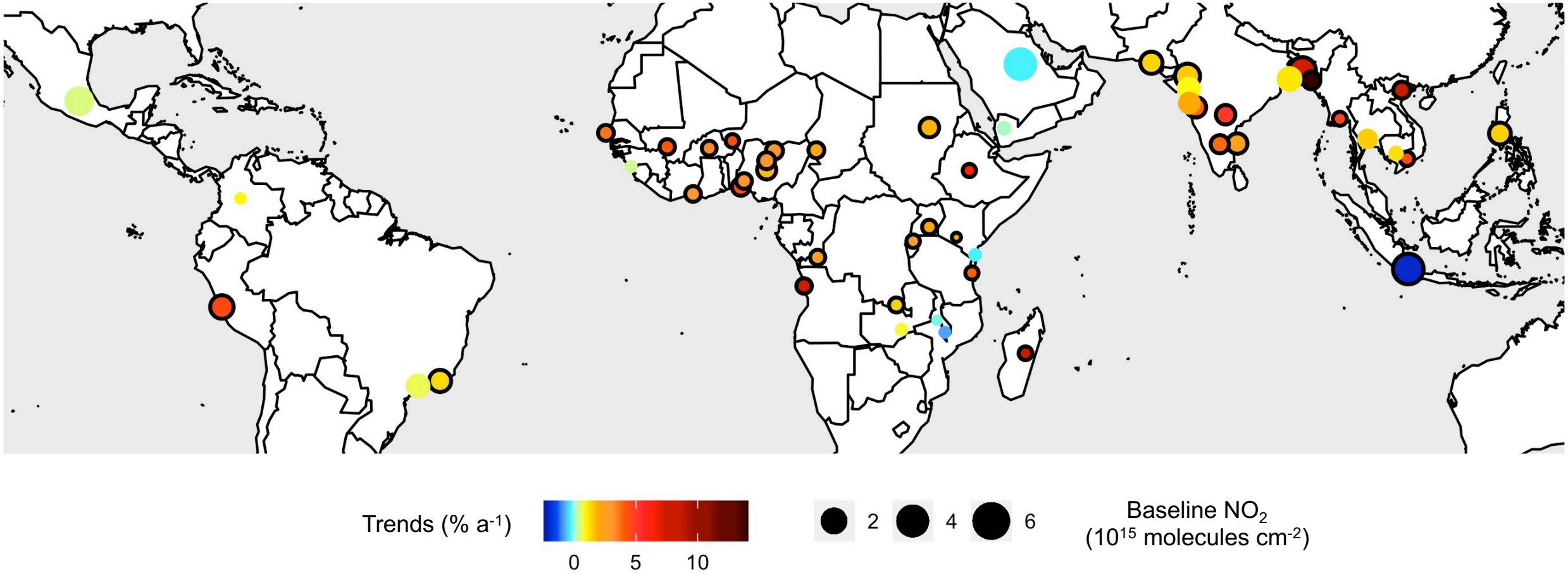




Trends in NO_x, NH_3, and NMVOCs concentrations relate directly to trends in emissions

Application to Megacities of the Future

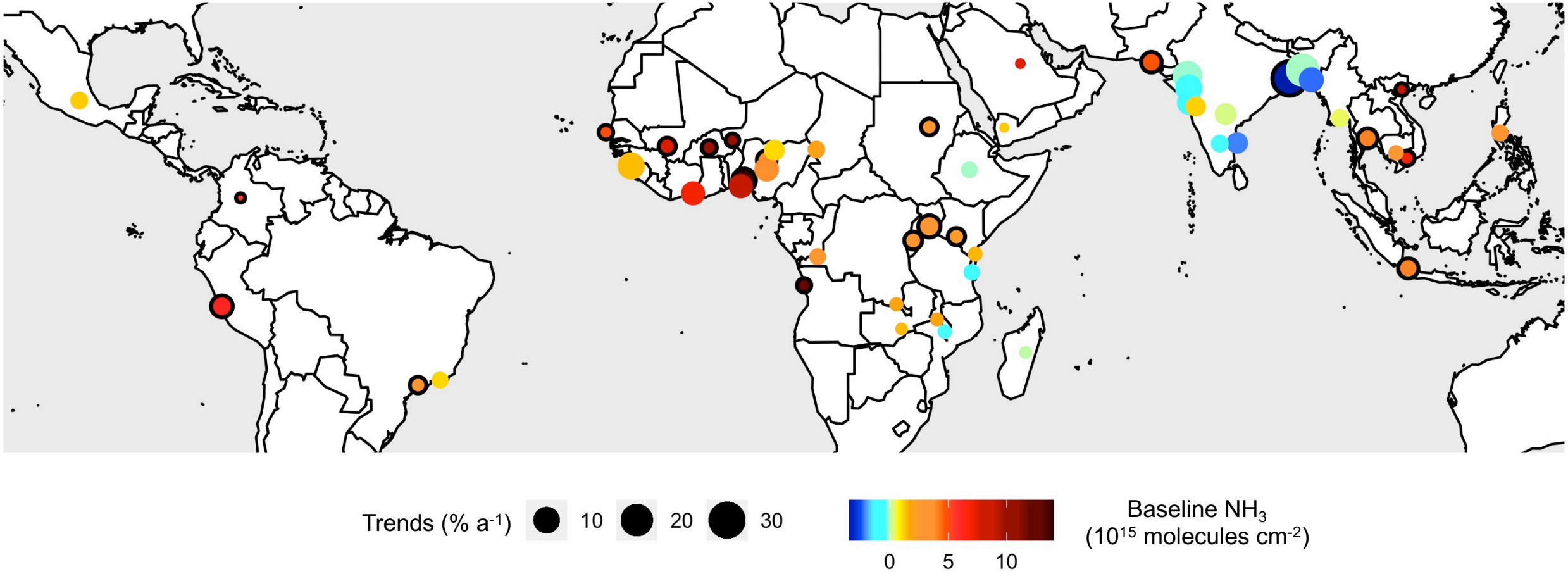
NO_2 trends from 2005 to 2018



NO_2 has increased in 46 out of 51 cities

Application to Megacities of the Future

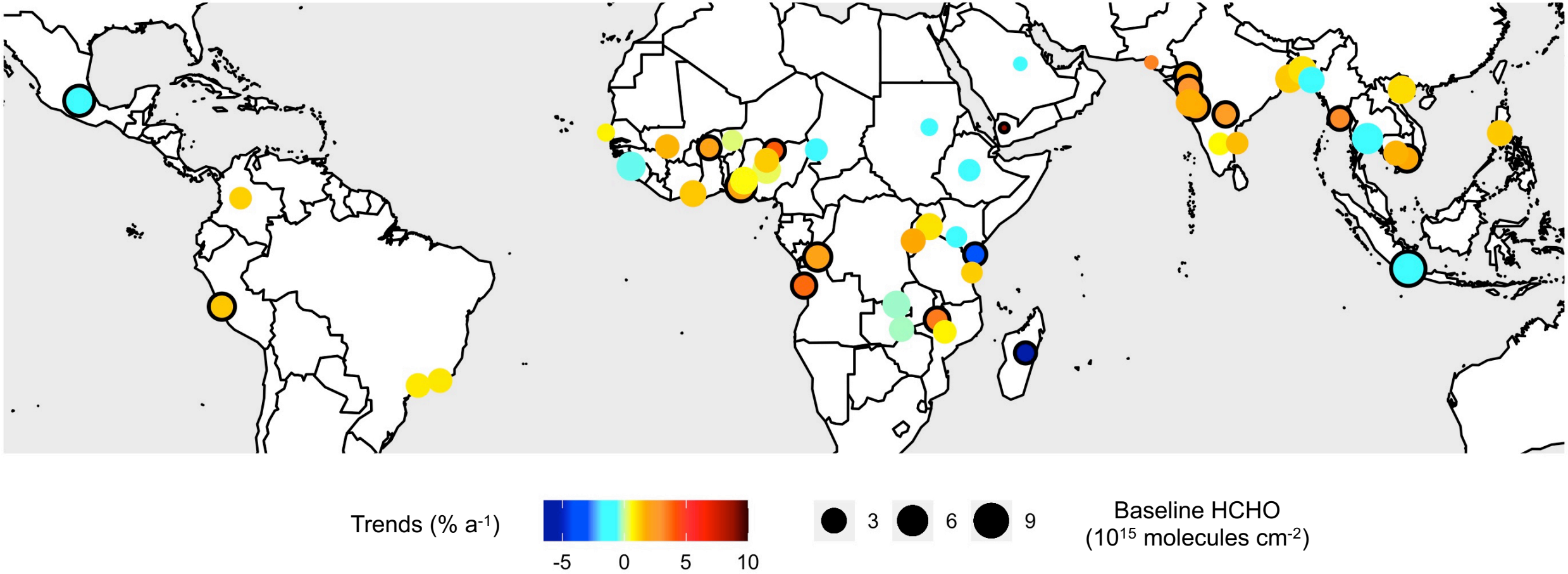
NH_3 trends from 2007 to 2018



NH_3 has increased in 40 out of 51 cities

Application to Megacities of the Future

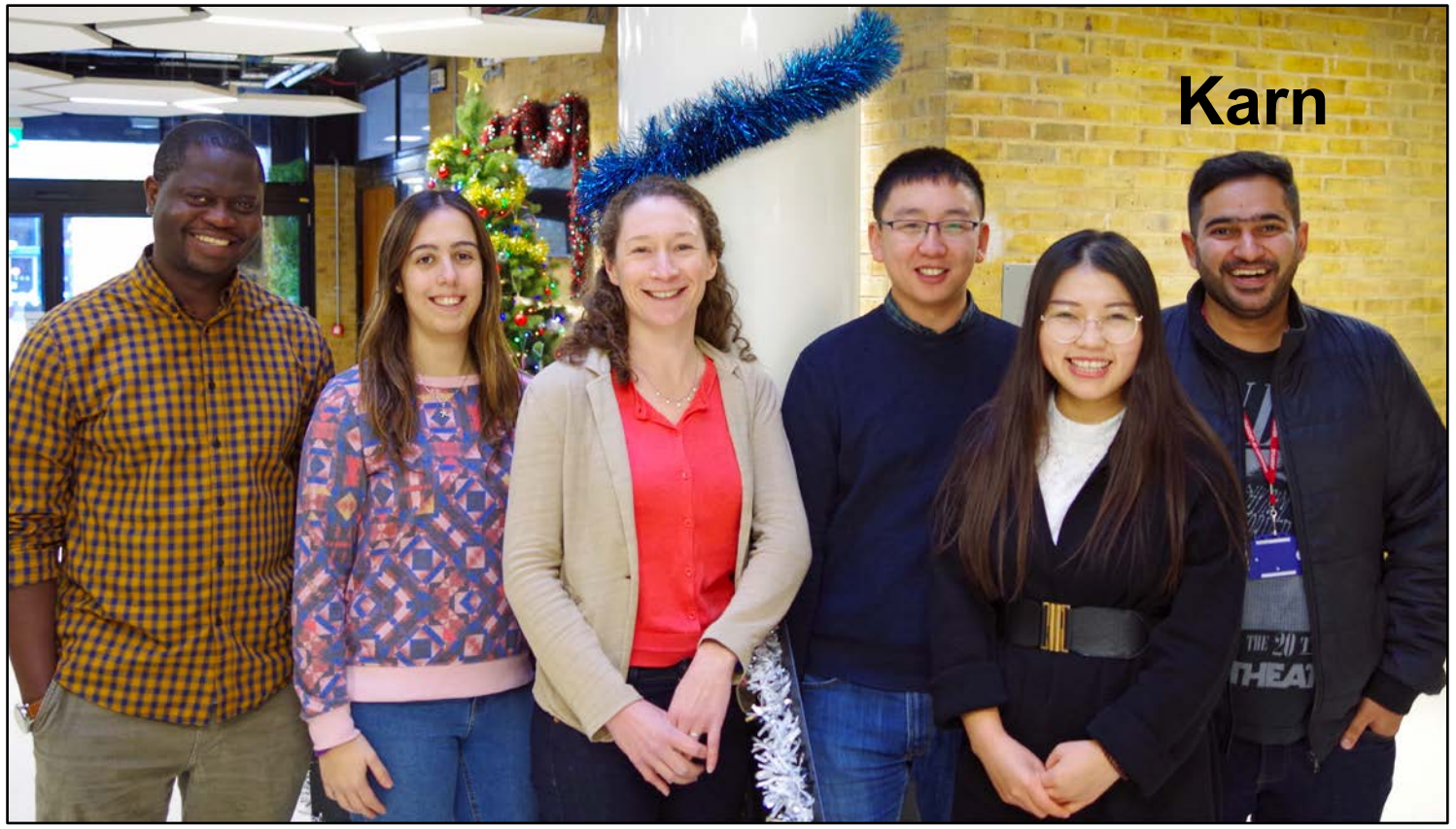
HCHO (reactive NMVOCs) trends from 2005 to 2018



HCHO (reactive NMVOCs) has increased in 37 out of 51 cities

Acknowledgements

Marais Research Group



Alfred, Irma (visiting student), Eloise, Gongda, Nana, Karn

Work presented is by my PhD student, **Karn Vohra**

Work presented has been submitted for peer-review (**Vohra et al., 2020**)

To find out about other exciting project activities in our group, visit http://maraisresearchgroup.co.uk/

Any Queries? Email eloise.marais@le.ac.uk

Thank you for your time!