Air quality trends from long-term Earth observations over tropical megacities of the future

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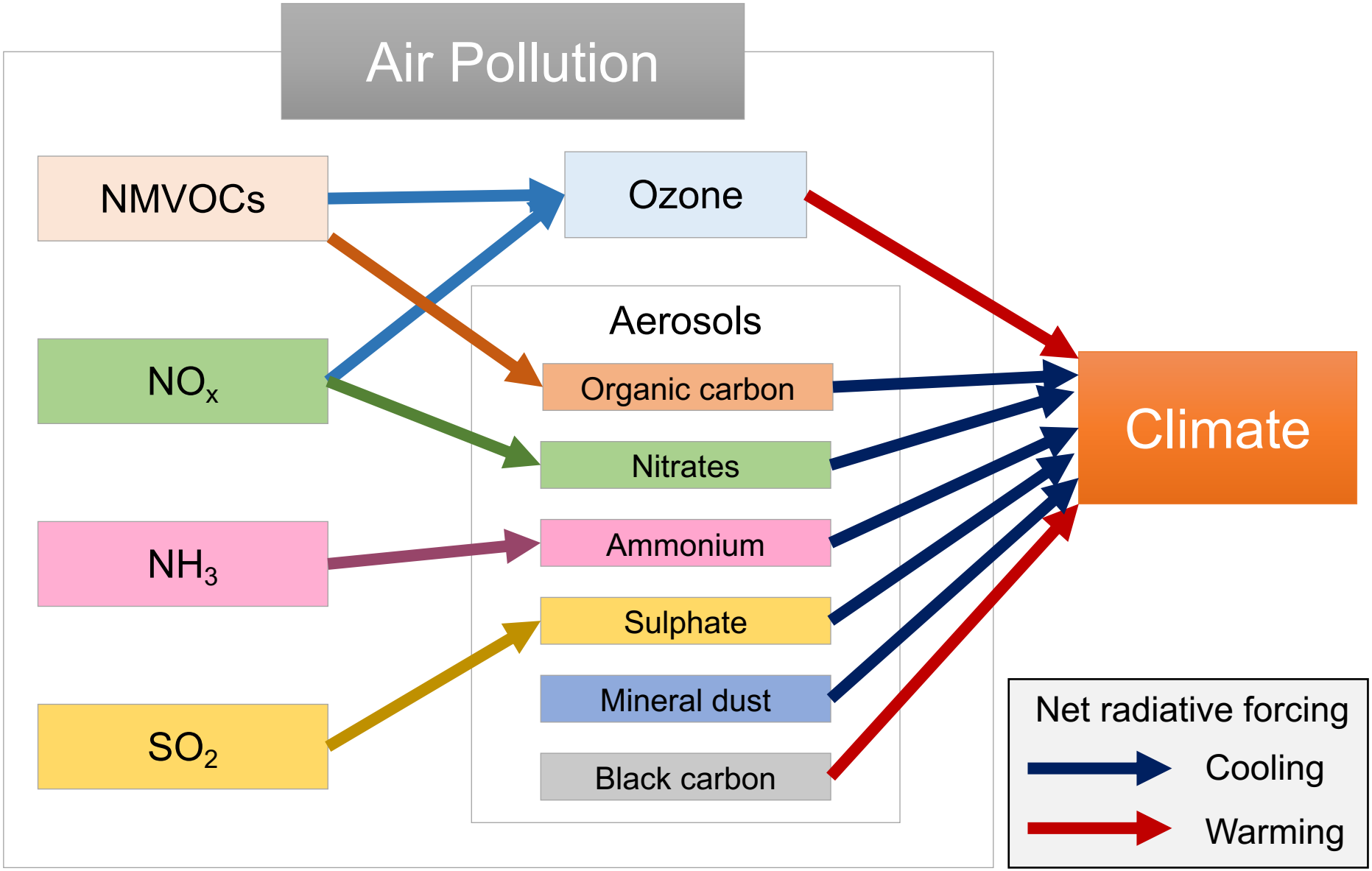
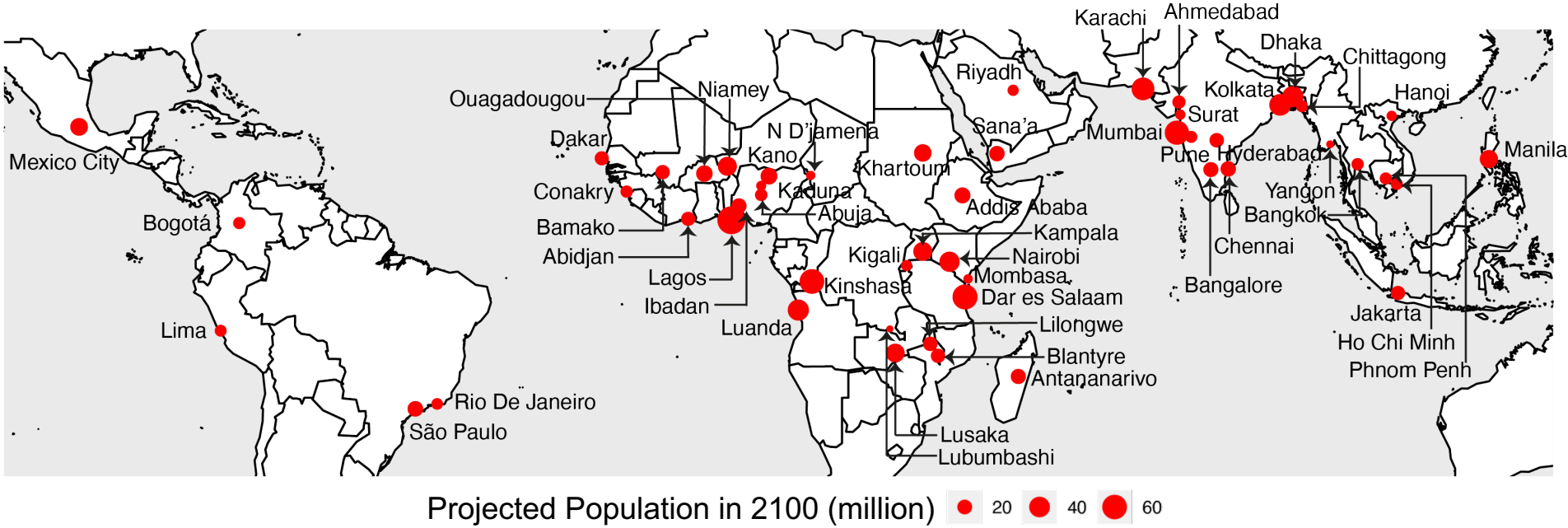
Air Quality and Climate are inter-linked



Tropics are the next frontier in air pollution

51 cities within the tropics will be megacities by 2100 **[Hoornweg & Pope, 2016]**



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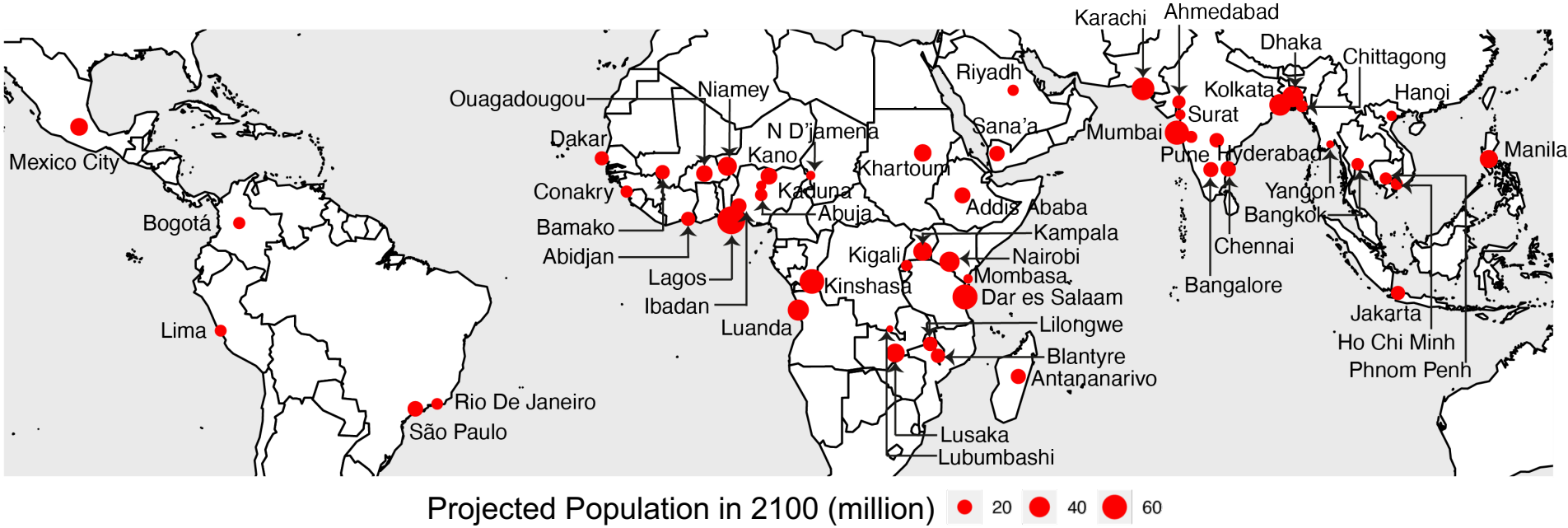
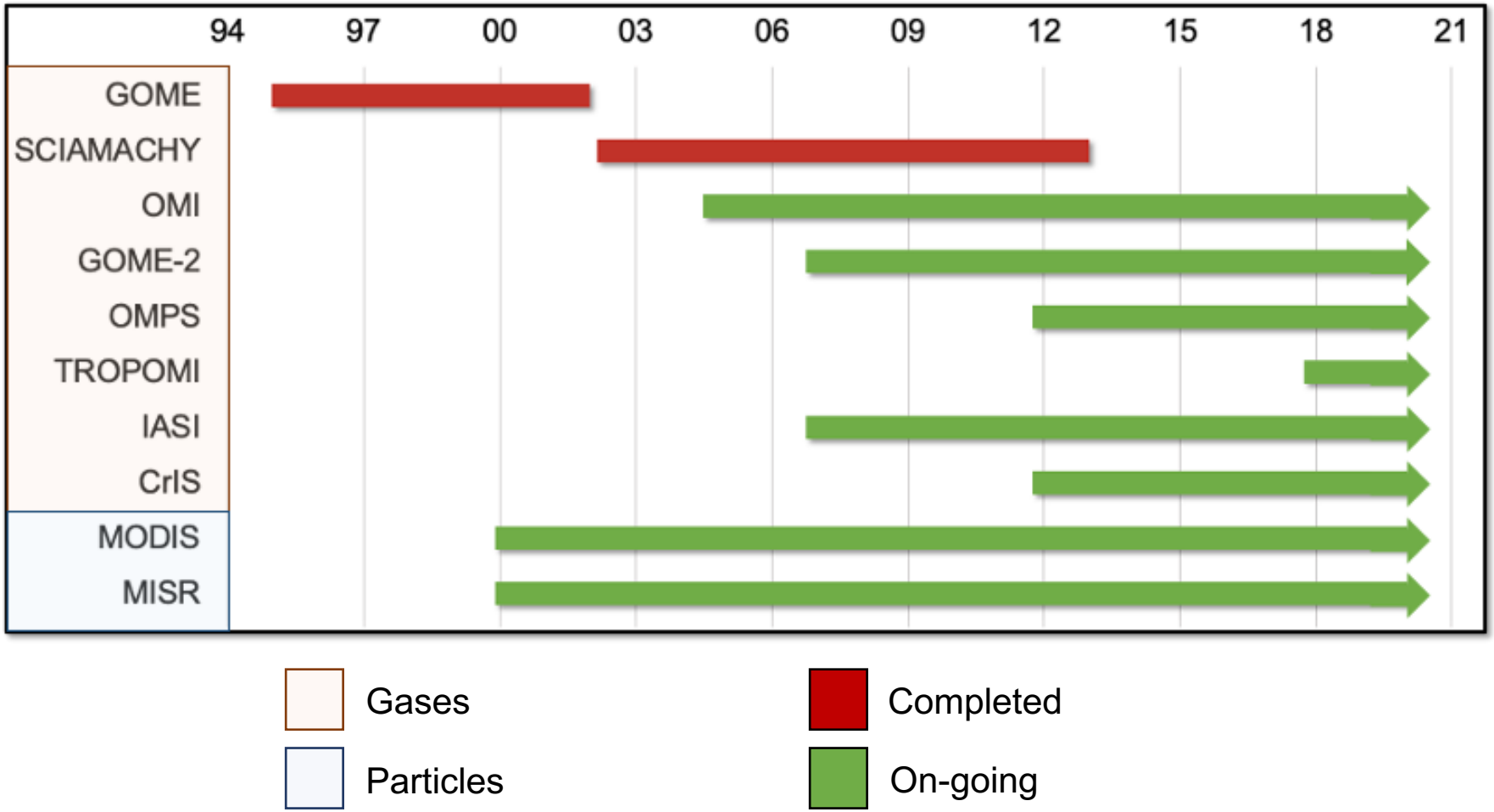


Currently, limited routine monitoring across the tropics

Data source : OpenAQ

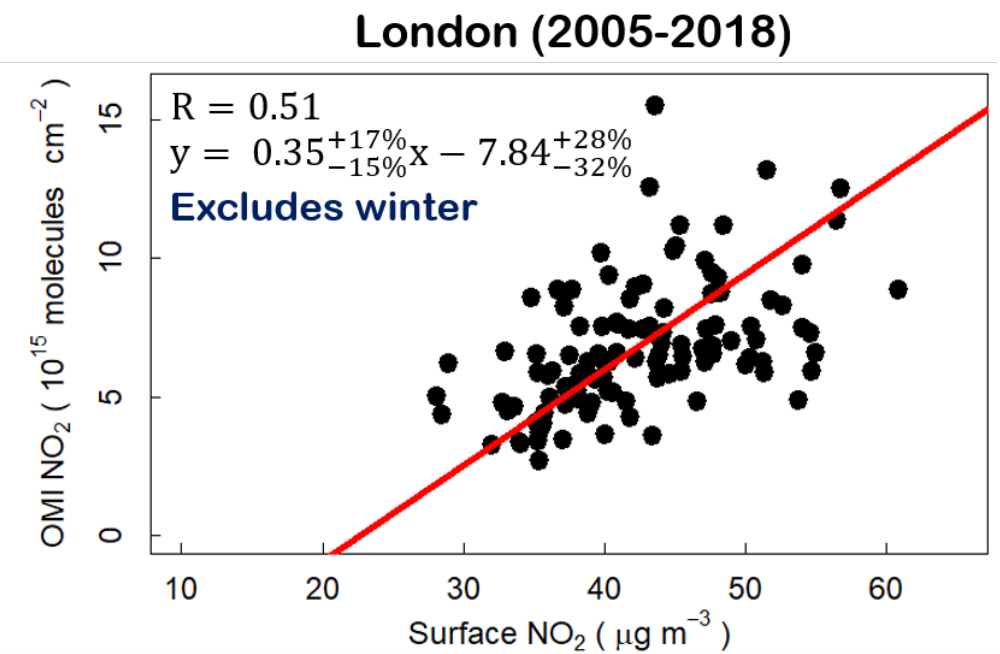
Satellites are the only solution!!!

Sensors in space have been providing us with petabytes of data for more than 2 decades

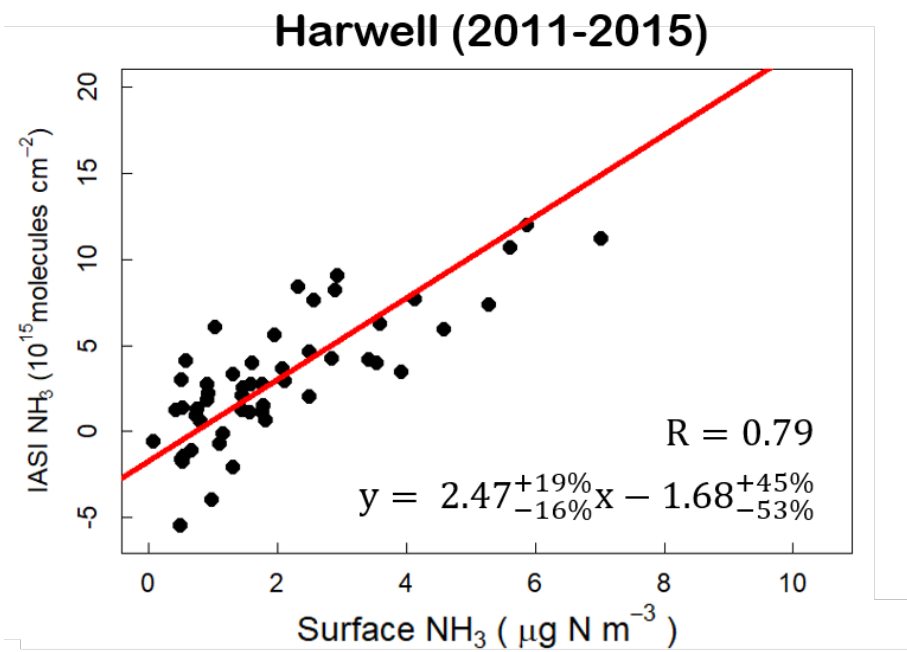


Validation of satellite observations

Satellite versus surface NO_2 in London



Satellite versus surface NH_3 in Harwell



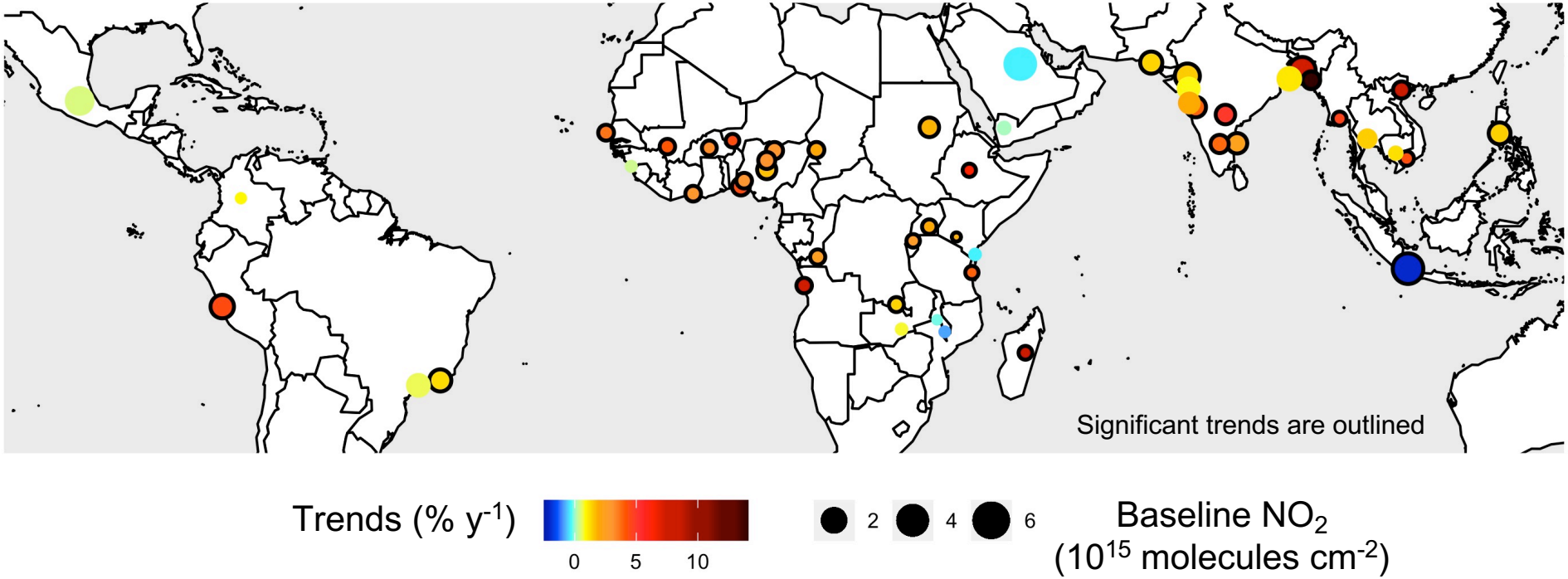
In our previous work for the UK we showed that the satellite observations reproduce monthly variability in surface pollutant concentrations

[Vohra et al., submitted, *ACP*]

Megacity NO_2 trends from OMI for 2005-2018

NO_2 is a precursor of tropospheric ozone, inorganic & organic nitrate aerosol

NASA OMI Level-2 Tropospheric column NO_2 version 3.0



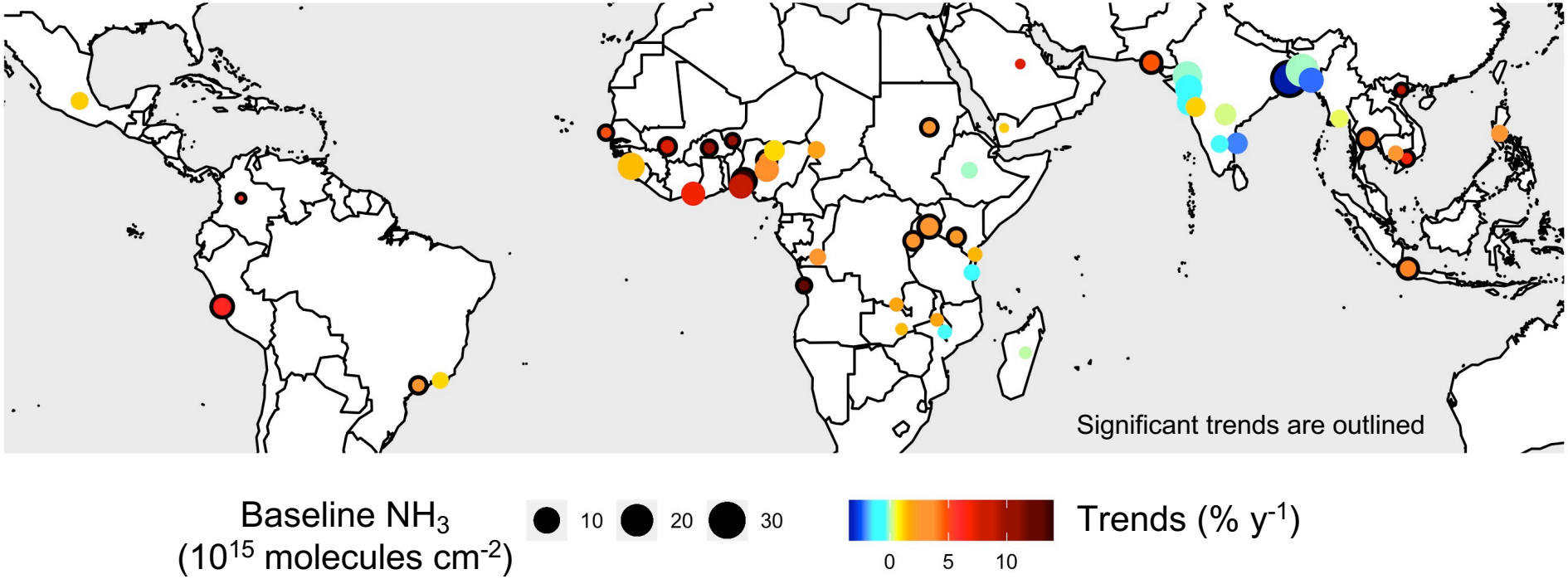
NO_2 has increased in 46 out of 51 cities

Year-round sources include anthropogenic sources like fossil fuel combustion, with large seasonal contributions from biomass burning

Megacity NH_3 trends from IASI for 2008-2018

NH_3 is a precursor of inorganic nitrate aerosol

BIRA IASI Level-2 Total column NH_3 version 3R



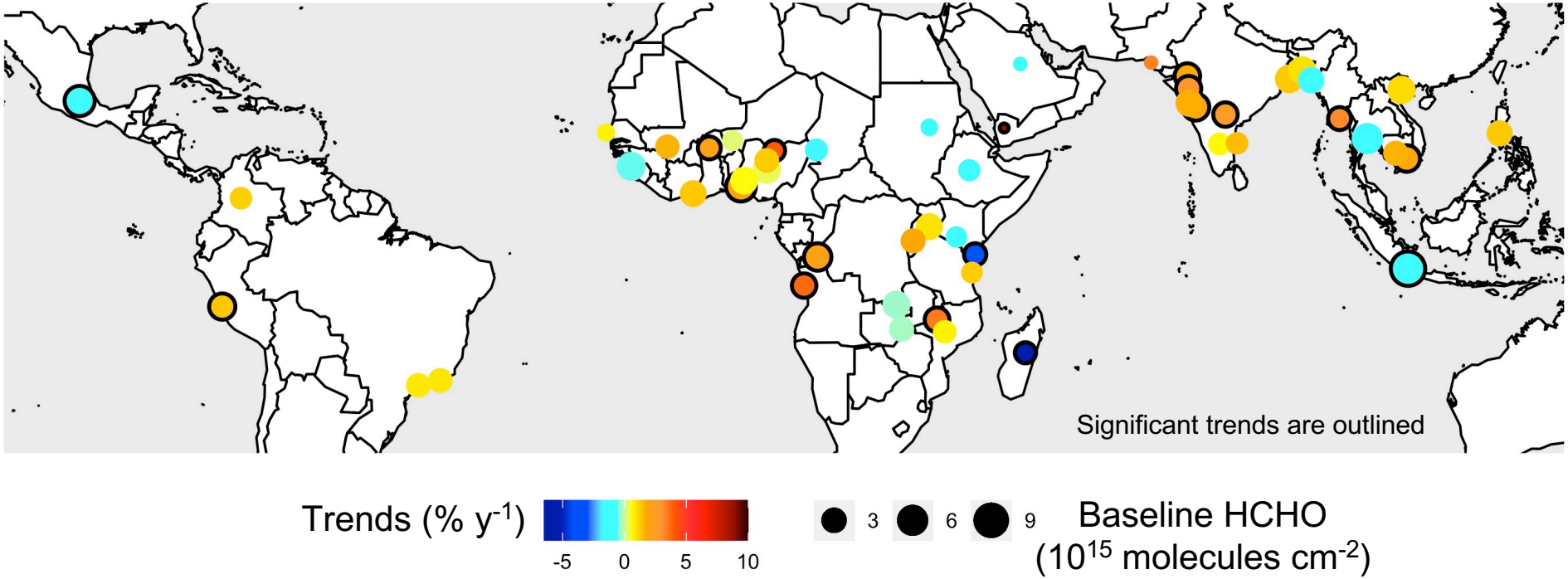
NH_3 has increased in 40 out of 51 cities

Year-round sources include agriculture, fertilizer industry, urban sources like cars and seasonal contributions are from biomass burning

Megacity HCHO trends from OMI for 2005-2018

HCHO is a precursor of tropospheric ozone & carbon dioxide

QA4ECV OMI Level-2 Total column HCHO version 1.2



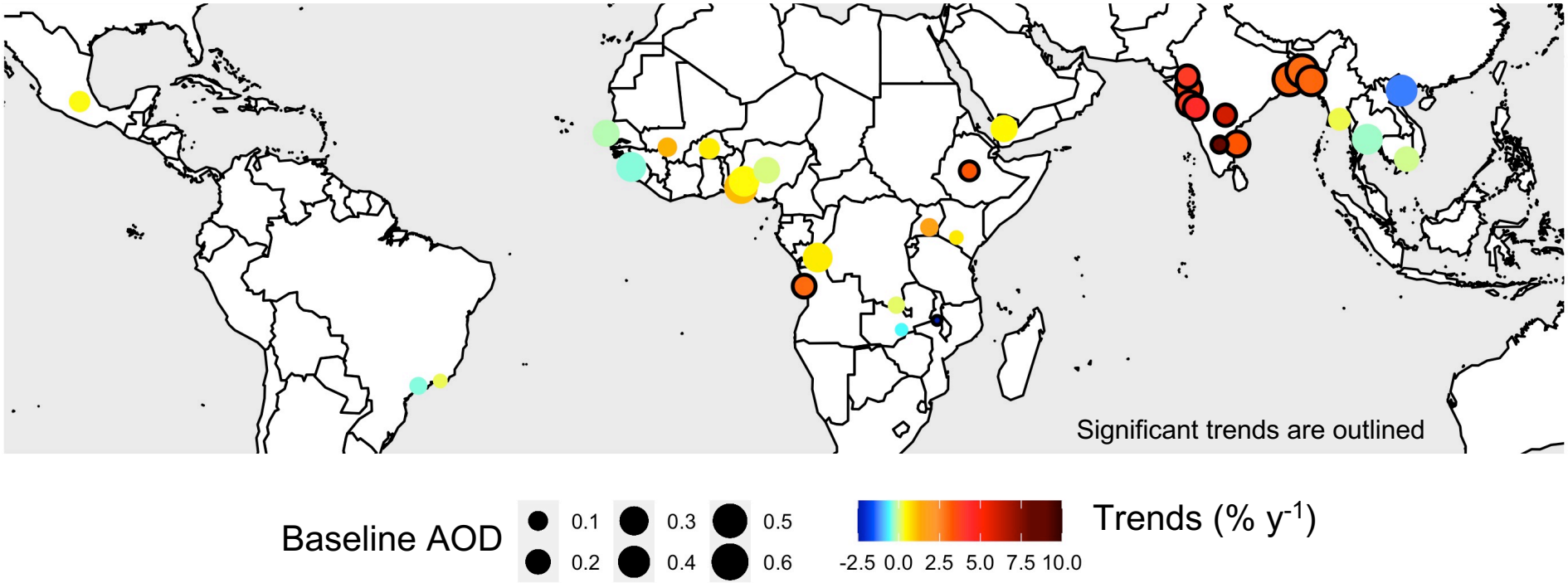
HCHO (reactive NMVOCs) has increased in 37 out of 51 cities

Year-round sources include anthropogenic sources (industry and domestic combustion) and biogenic sources, with seasonal contributions from biomass burning

Megacity AOD trends from MODIS for 2005-2018

Aerosols can be either absorbing or scattering

NASA MODIS Level-2 Dark Target AOD Collection 6.1



AOD has increased in 25 out of 33 cities

Dominant sources are many: secondary sources from NO_x, NH_3, NMVOCs, primary sources of windblown dust, crop and trash burning, residential and open fires

Conclusion and Next Steps

- ✓ Preliminary results show rapid increases in precursors of short-lived climate forcers for most future tropical megacities

Next, we will:

- Interpret the drivers of these trends, for example, increased fertiliser use in Africa driving increases in NH_3
- Tease out biomass burning contribution to the trends
- Compare trends to widely used global emission inventories like CEDS/EDGAR to see if the information to calculate radiative forcing has been correctly applied

Any Questions? Contact Karn (kxv745@bham.ac.uk)