TRENDS IN CITY-WIDE AIR QUALITY AS OBSERVED FROM SPACE

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1. INTRODUCTION

- Each year **40,000** early deaths in UK and **620,000** in India are attributed to **fine particles**, ozone and **NO_2** pollution; Associated health cost in UK : **£6 billion**
- Here we choose 4 cities at different stages of development: **London** (developed, $PM_{2.5}$:**12** µg/m^3) and **Birmingham** (urban renewal, $PM_{2.5}$:**10** µg/m^3) in the UK, and **New Delhi** (semi-developed, $PM_{2.5}$:**143** µg/m^3) and **Kanpur** (developing, $PM_{2.5}$:**173** µg/m^3) in India
- Space-based instruments provide long-term observations of air pollutants to assess the effect of rapid development and policy on air quality; we validate and use satellite observations to assess air quality in the 4 target cities in the UK and India

2. METHODOLOGY

- Validate satellite observations of NO_2 from the ***Ozone Monitoring Instrument (OMI)*** on-board **NASA's Aura satellite** with **Defra, Birmingham City Council** and **London Air Quality Network** ground-based observations and validate satellite observations of NH_3 from the ***Infrared Atmospheric Sounding Interferometer (IASI)*** on-board **Metop-A satellite** with ground observations from **EMEP**'s supersites in the UK
- Quantify the long-term trend in satellite observations of NO_2, NH_3, HCHO (proxy for NMVOCs) and AOD (proxy for $PM_{2.5}$) for the target cities in the UK and India

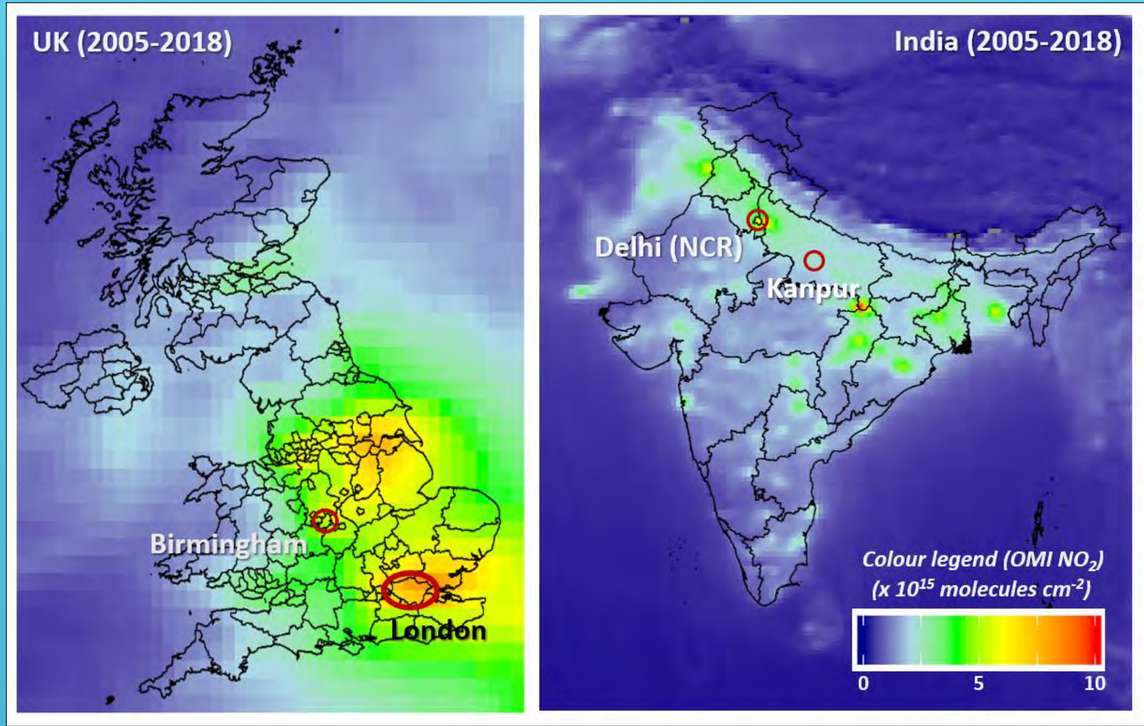

Figure 1. Maps of the UK and India showing hotspots of NO_2 pollution as observed from space and locations of the target cities in the two countries

3. SURFACE MONITORING OF NO_2

- Dense but periodic network of 120 monitoring sites in Greater London
- Sparse and periodic network of 8 sites in Birmingham
- Outlined points are sites with temporal overlap that we use to compare to OMI NO_2 tropospheric columns (46 for London and 6 for Birmingham)

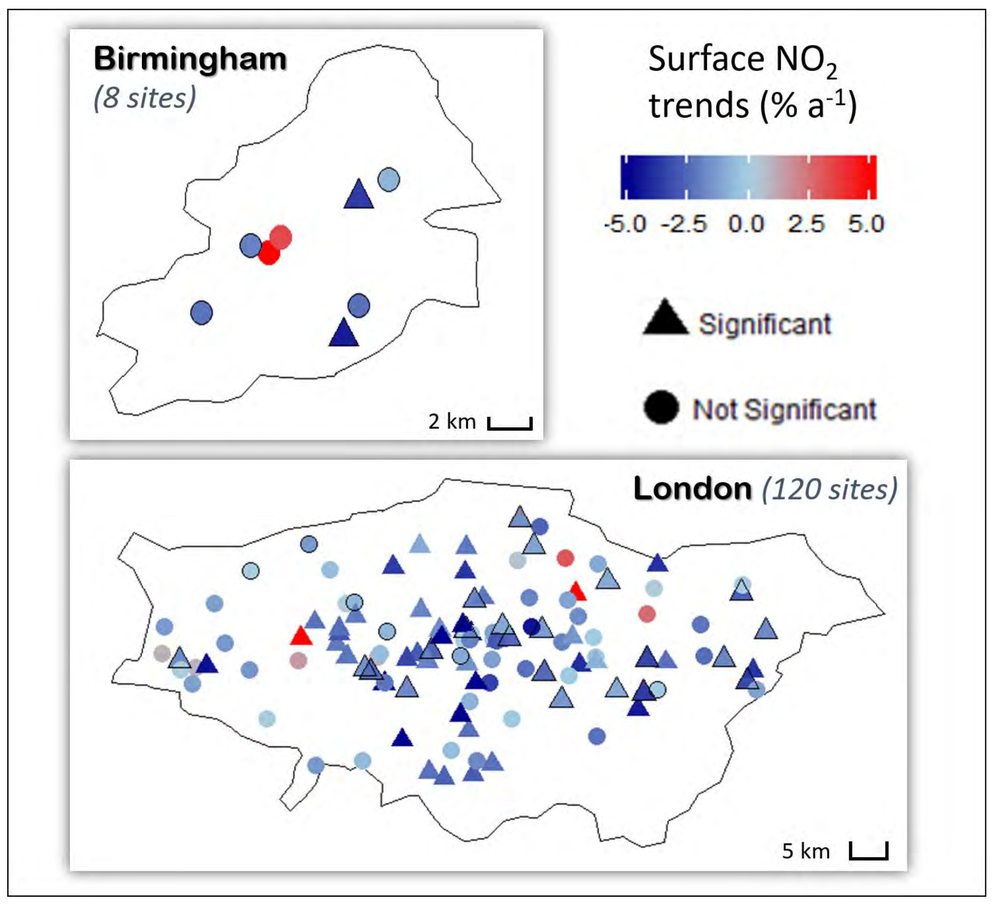

Figure 2. Trends and locations of NO_2 monitoring sites in London and Birmingham

4. VALIDATION OF SATELLITE OBSERVATIONS

- Assessed temporal consistency between monthly means of satellite and surface NO_2 for London and Birmingham; For London, R = 0.51 for all months excluding DJF (shown alongside) and R = 0.33 for DJF only and for Birmingham, R = 0.71 for all months excluding DJF and R = 0.69 for DJF only
- Satellite-based NH_3 assessed against the surface observations from rural supersites in the UK; R = 0.60 for Harwell (shown alongside), R = 0.79 for Chilbolton Observatory, R = 0.46 for Auchencorth Moss
- Consistent monthly means of satellite and ground-based NO_2 and NH_3 give us confidence to apply satellite observations to monitor air quality for cities in UK

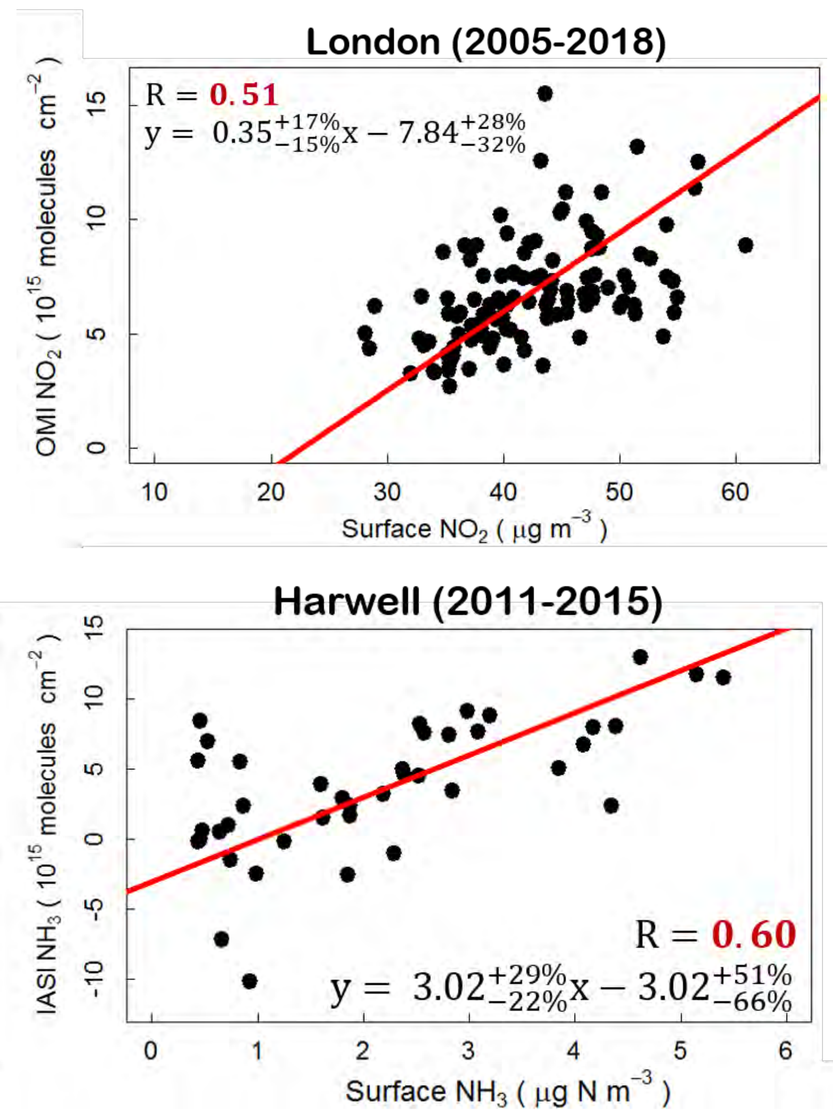

Figure 3. Evaluation of monthly means of satellite column against ground observations – NO_2 in London for non-winter (top) and NH_3 in Harwell (bottom)

5. TRENDS IN AIR QUALITY IN THE UK AND IN INDIA

- We observe linear trends in monthly means of OMI NO_2 , IASI NH_3, OMI HCHO and Moderate Resolution Imaging Spectroradiometer (MODIS) AOD in the target cities
- Air quality is improving in the UK cities (significant decrease in NO_x emissions; 35 % in 2005-2018) while it is degrading in the cities in India (significant increase in $PM_{2.5}$ emissions; 36-44 % in 2005-2018)

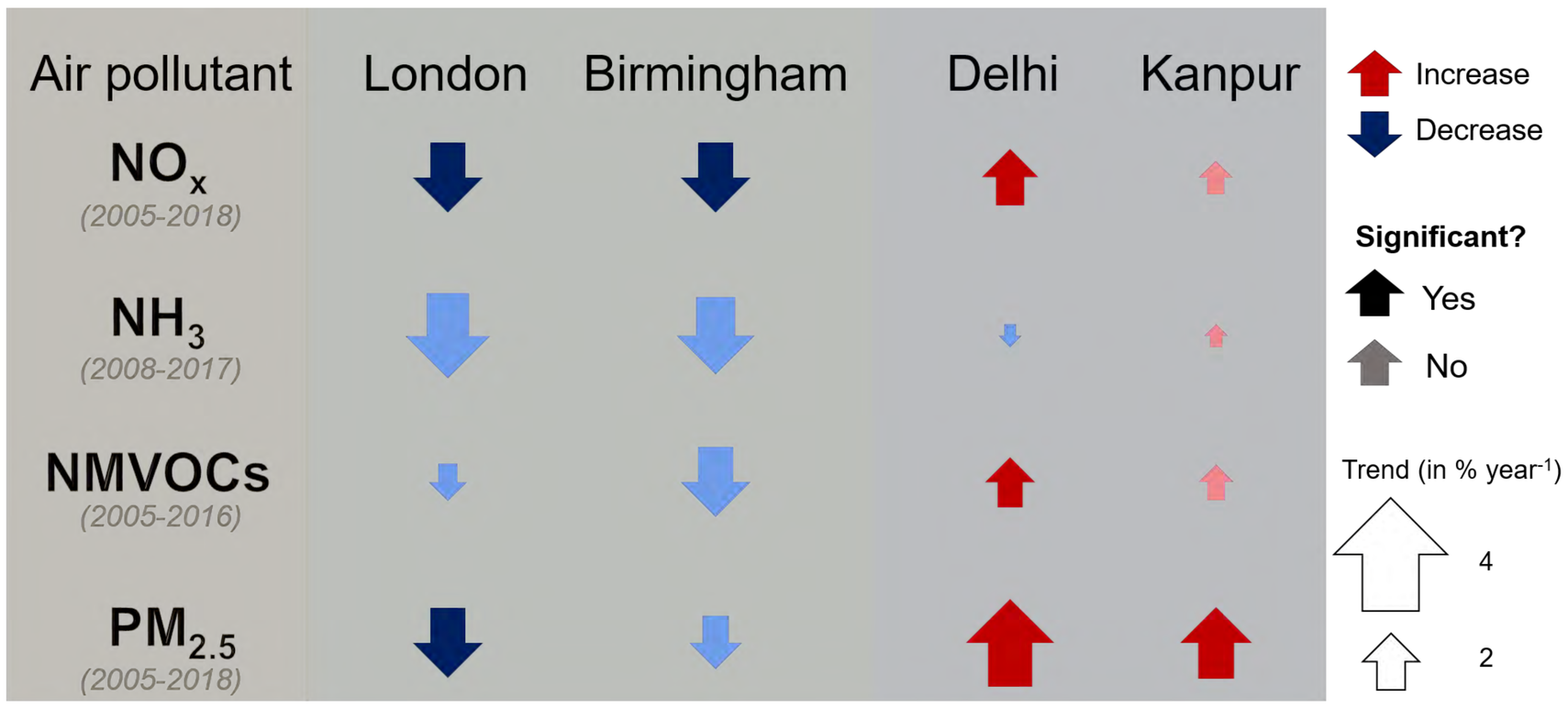

Figure 4. Long-term trends of satellite observations of air pollutants for select cities in the UK and India

6. NEXT STEPS

- Validate satellite measurements of HCHO and AOD against available surface observations of NMVOCs and $PM_{2.5}$
- Evaluate existing **air quality models** using satellite observations

5-SECOND SUMMARY

The direction of trends in air quality for all the select cities is consistent with other studies using satellite observations but the magnitudes are different owing to the differences in instruments and time periods

REFERENCES

- Lamsal et al., JGR, doi:10.1029/2007JD009235, 2008
- Celarier et al., JGR, doi:10.1029/2007JD008908, 2008
- Geddes et al., EHP, doi:10.1289/ehp.1409567, 2016
- Ul-Haq et al., AIM, doi:10.1155/2015/959284, 2015
- Birmingham City Council https://bit.ly/2KbBNTI
- Pope et al., ASL, doi:10.1002/asl.817, 2018
- DEFRA report https://bit.ly/2HU4cPI