Integrating Earth observations in the UK air quality management strategy

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TRACE

INTRODUCTION

Space-based instruments have been providing us with global observations of the atmosphere since the 1990s, starting with GOME in 1996 and amounting to petabytes of data of invaluable information to understand dynamic changes in air quality in cities.

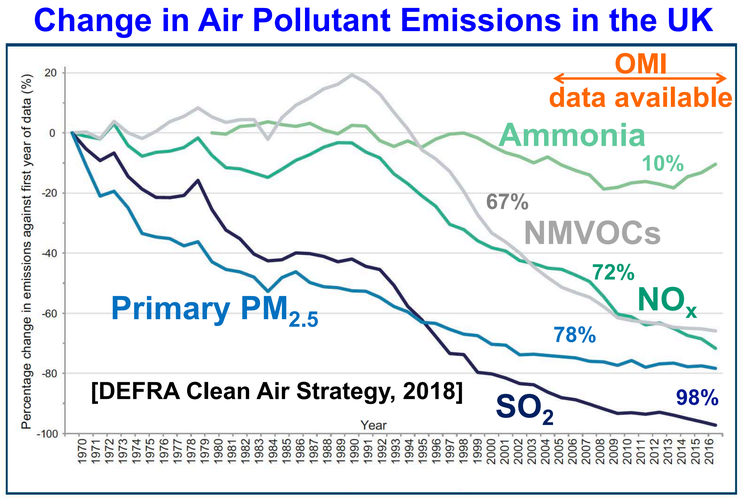
The amount if this data used in monitoring air quality and developing air pollution mitigation strategies in the UK to date: ZERO!

Here we present first steps in a collaborative effort (academia, innovation hub, local and national authorities) to integrate Earth observations of air pollutants in the UK air quality strategy and develop an end user tool, TRACE (Tool for Recording and Assessing the City Environment) that converts Earth observations into useful information about city-scale air quality and country-wide emissions.

OPPORTUNITIES TO INTEGRATE EARTH OBSERVATIONS IN AIR QUALITY POLICY IN THE UK

Determine long-term changes in concentrations and emissions of NO_x using the 14-year record of observations from the Ozone Monitoring Instrument (OMI) and evaluate spatial representation of ammonia emissions using the Infrared Atmospheric Sounding Interferometer (IASI) and the GEOS-Chem chemical transport model.

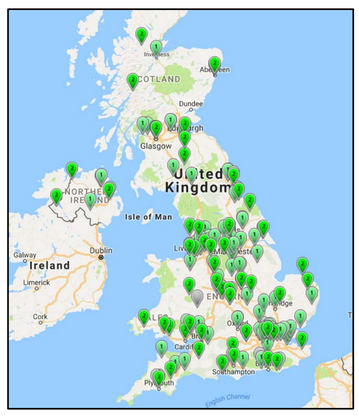
Change in Air Pollutant Emissions in the UK



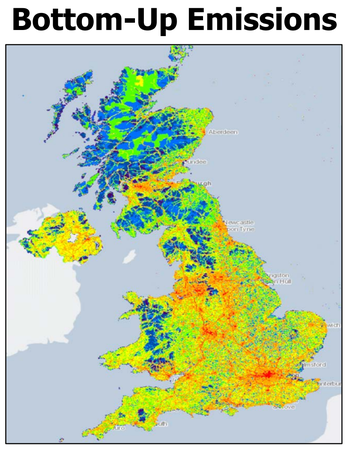
All emissions, except ammonia (NH_3) have declined substantially in the UK.

Current Tools Used to Monitor, Assess, and Improve Air Quality in the UK

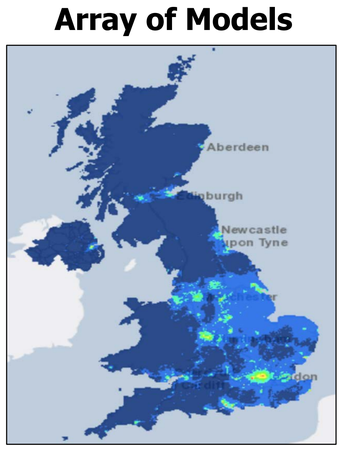
Surface Network



Bottom-Up Emissions



Array of Models



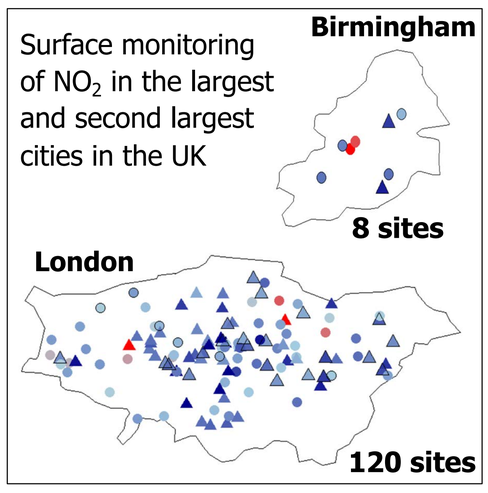
Data available on UK-AIR data archive: uk-air.defra.gov.uk/

Costly, laborious, gaps in space, time, frequency, and pollutants, National Atmospheric Emission Inventory (NAEI) inconsistent from year-to-year, limited validation of tools.

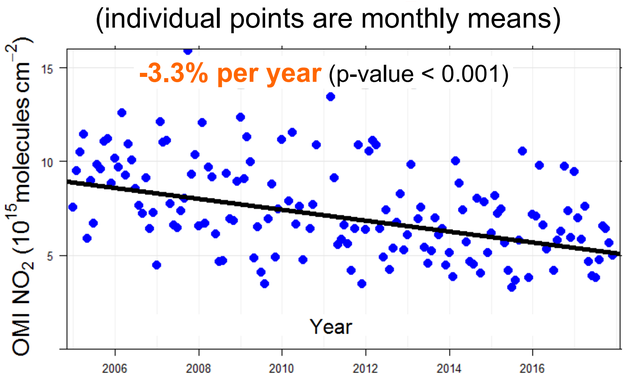
LONG-TERM TRENDS IN NITROGEN OXIDES ($NO_X \equiv NO + NO_2$)

NO_x is a precursor of ozone and aerosol nitrate ($PM_{2.5}$) and NO_2 is linked to hazardous health outcomes. Most NO_x in the UK is from diesel vehicles.

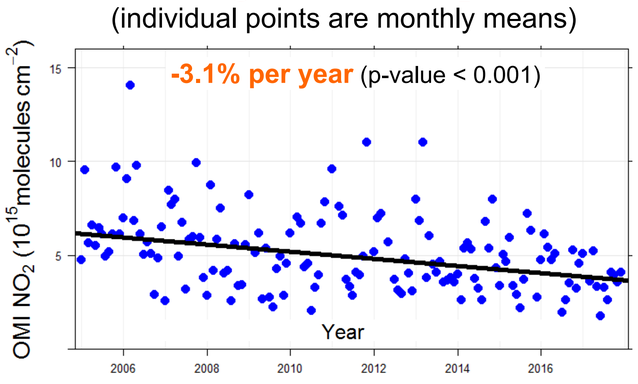
NO_2 is the most extensively sampled air pollutant in the UK, but still there are large monitoring gaps in space and time.



London OMI NO_2 trend
(individual points are monthly means)



Birmingham OMI NO_2 trend
(individual points are monthly means)



Similar decline in NO_2 due to emission controls in London and Birmingham.

Decline in NO_2 in London estimated with the surface network is only 1.8% a^{-1}.

Not possible to estimate trends with the Birmingham surface network (no long-term sites).

For more on OMI NO_2 validation and trends in cities in the UK and India, visit Karn Vohra's poster in this session: poster number 2364.

EMISSIONS OF AMMONIA

Ammonia (NH_3) is a semi-volatile gas that partitions between the gas and aerosol phase and, when in the aerosol phase, contributes to $PM_{2.5}$.

NH_3 in the UK (as in the US) is mostly from agriculture. Effective mitigation strategies are challenging and require improved emission estimates.

Annual mean IASI (background) and Defra (circles) NH_3

Convert IASI NH_3 columns into emissions using GEOS-Chem.

IASI-derived NH_3 emissions

Compare to National Atmospheric Emission Inventory

NAEI NH_3 emissions

Satellite- and model-derived NH_3 emissions almost double the National Atmospheric Emission Inventory.

Large discrepancies in southwest UK and northern Ireland.

WHAT'S NEXT?

Evaluate GEOS-Chem NH_3 simulation with surface observations of gas-phase NH_3, aerosol-phase NH_4, and NH_x (NH_3+NH_4) wet deposition.

Use Earth observations of aerosol optical depth (AOD) to diagnose changes in $PM_{2.5}$ and of formaldehyde (HCHO) to diagnose changes in non-methane volatile organic compounds (NMVOCs).

MULTISECTOR CONTRIBUTORS

Funders

NERC SCIENCE OF THE ENVIRONMENT

EPSRC Engineering and Physical Sciences Research Council

Innovation Hub

CATAPULT Satellite Applications

CATAPULT Future Cities

Local authority

Birmingham City Council

National Agency

defra

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