WORLD METEOROLOGICAL ORGANIZATION STUDY ON THE CHANGES IN AIR QUALITY DURING THE COVID LOCKDOWN

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Format of presentation

- Background to the WMO/GAW study
- Observational analysis ~ 45 cities
- Improvement in air quality compared to WHO guidelines
- Modelling case study for UK
- Key conclusions and where next?

Issues when designing the study

WHO declared COVID-19 as a pandemic on 11 March 2020

Varied timelines for strictness and relaxation of lockdown periods – how to define comparison periods e.g. China, SE Asia, Italy, France and Spain, UK etc…

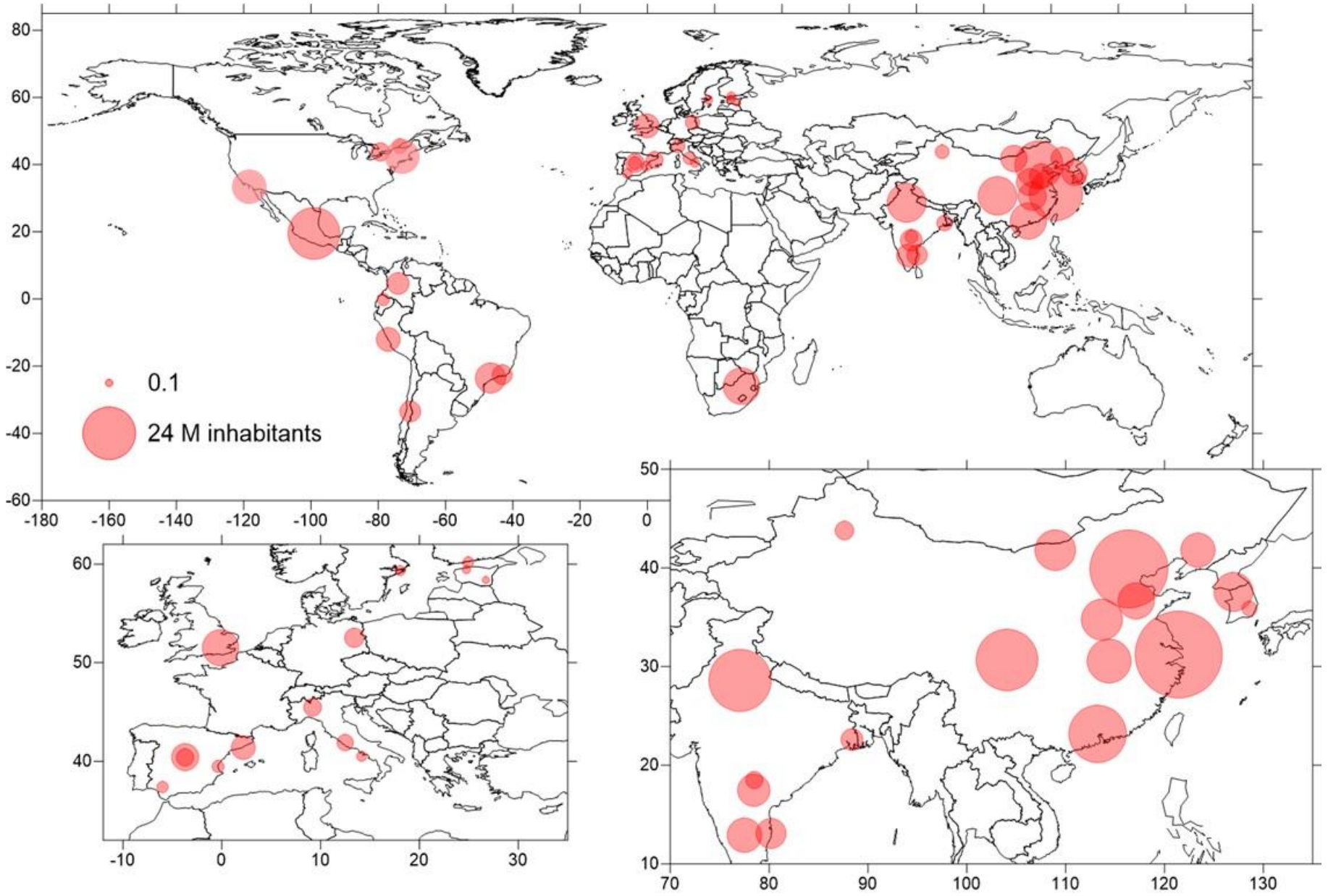
For observational analysis - five periods defined

For modelling analysis two period defined - Pre-lockdown and lockdown periods

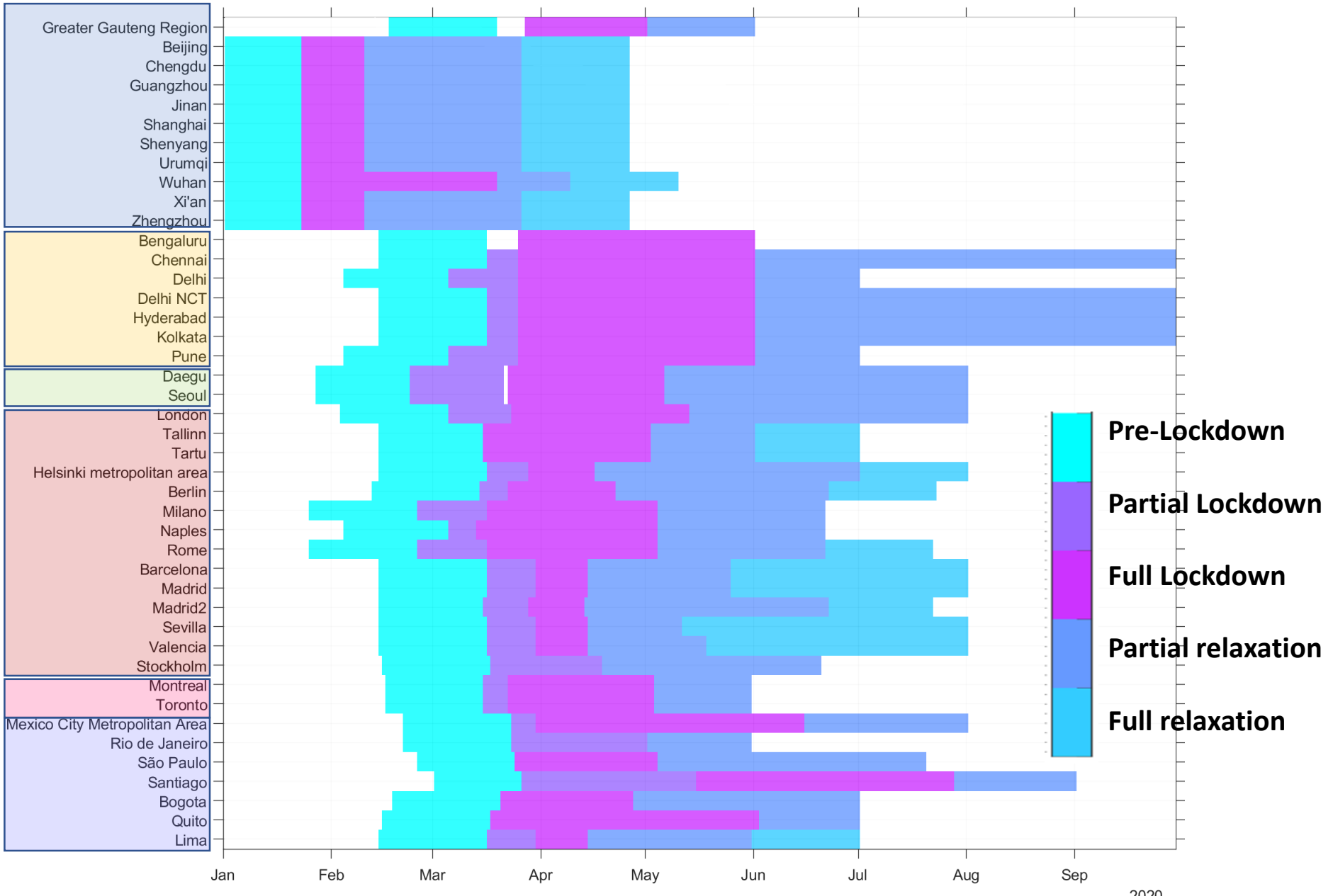
Meteorology - Complexity of how to account for meteorological differences year to year

Community input – expectation of more cities in the analysis

First phase of analysis
~ 45 Global cities

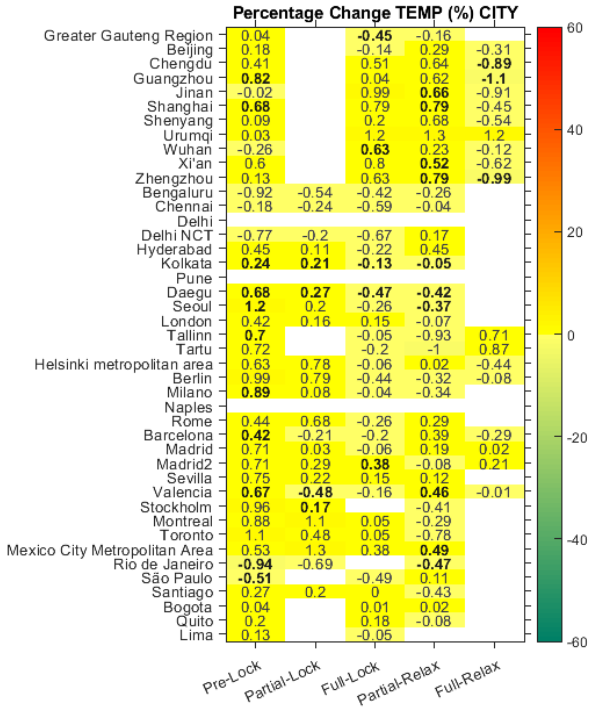


Lockdown periods across different cities

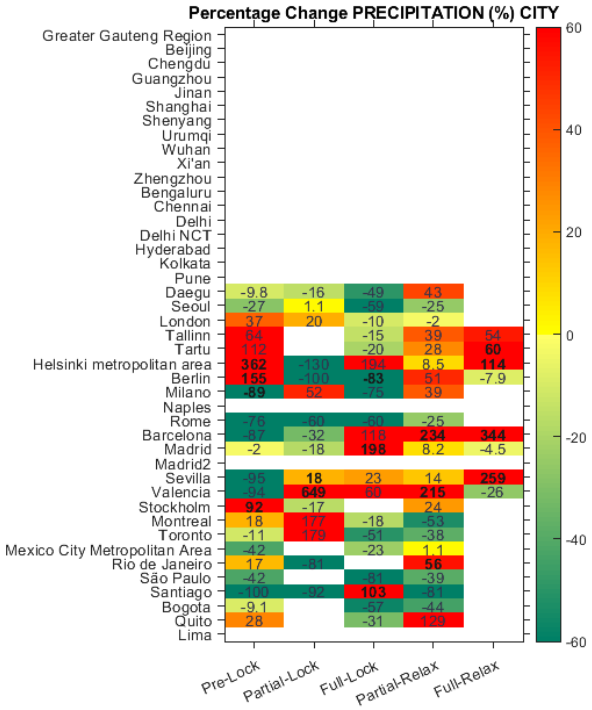


Changes in meteorology over different lockdown periods – comparison of 2020 to 2015-2019 mean

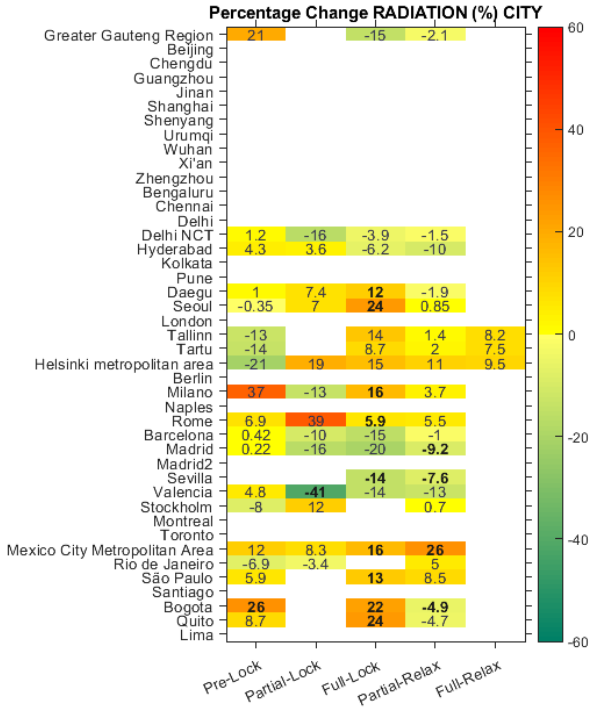
Temperature



Precipitation



Solar Radiation



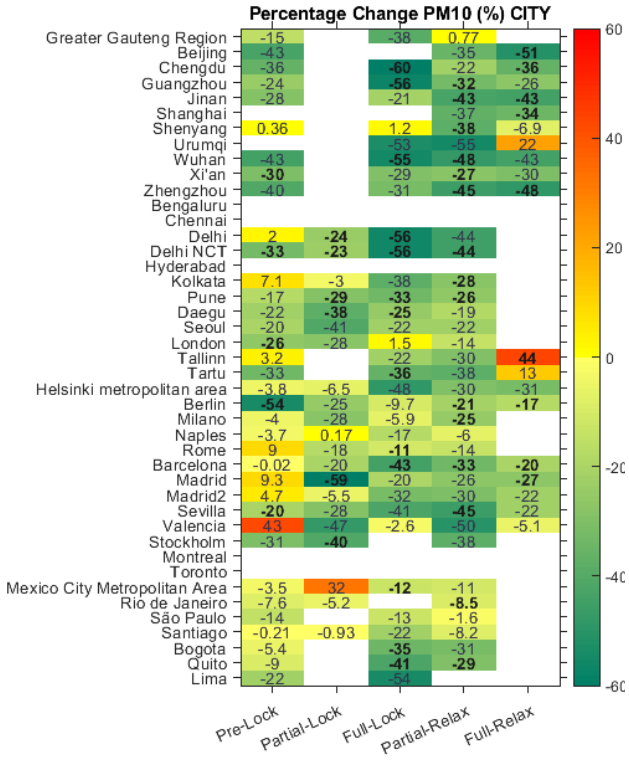
Other meteorological parameters: wind speed, RH

GAW

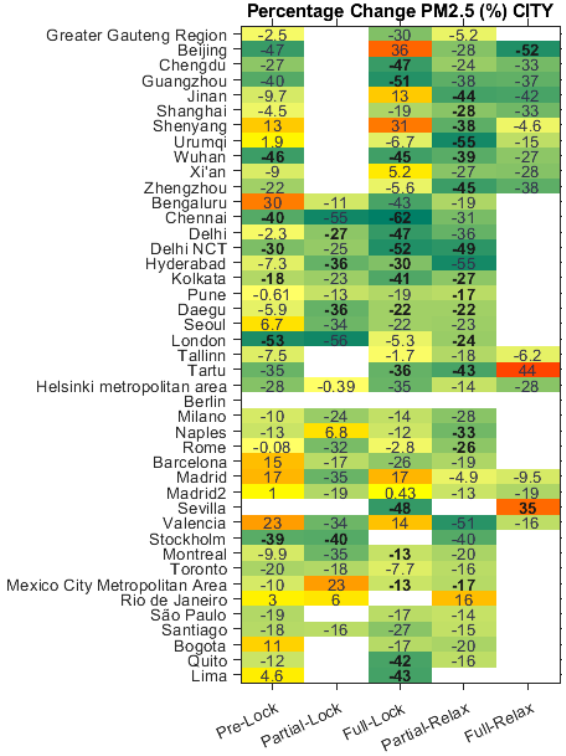
WMO

% Change in PM during different lockdown periods - comparison of 2020 to 2015-2019 mean

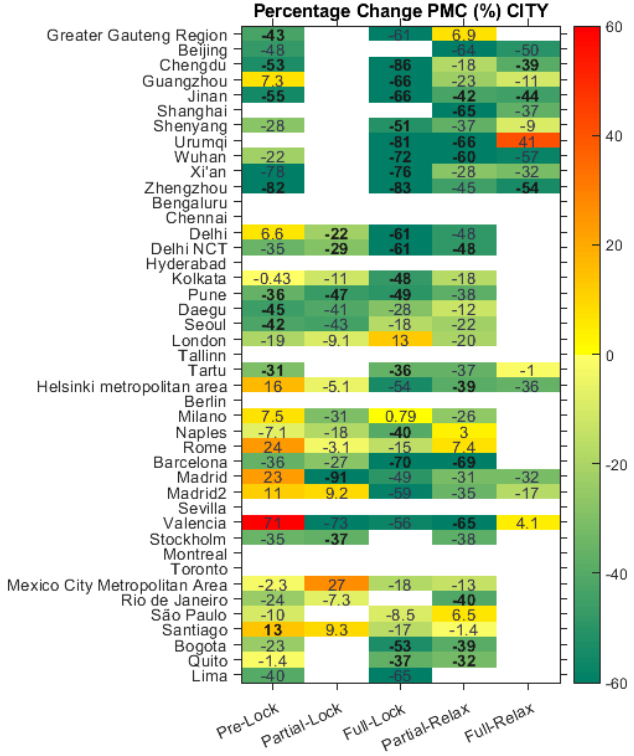
PM10



PM2.5

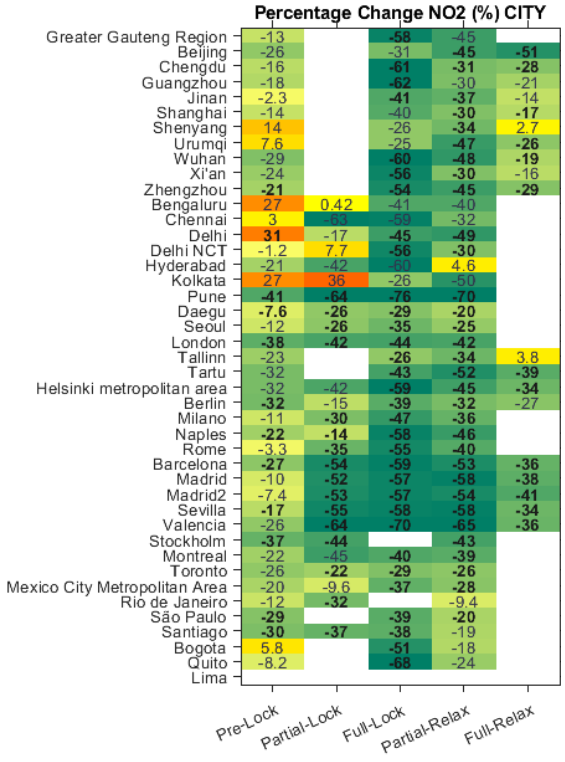


PMC

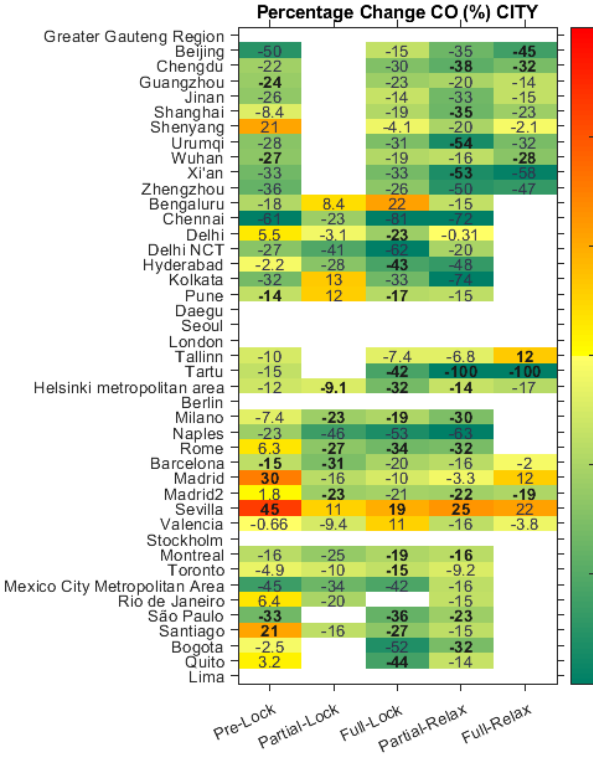


% Change in NO2, CO and CO/NOx ratio during lockdown periods - comparison of 2020 to 2015-2019 mean

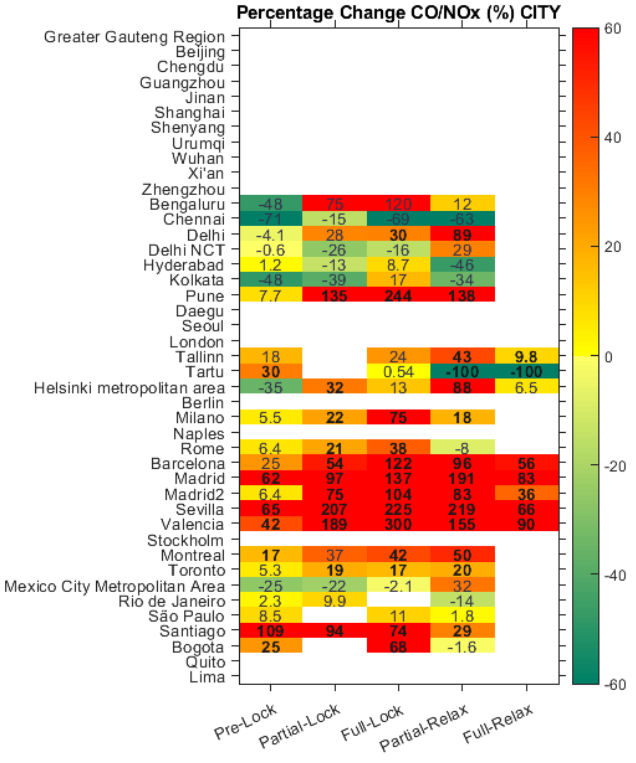
NO2



CO



CO/NOx

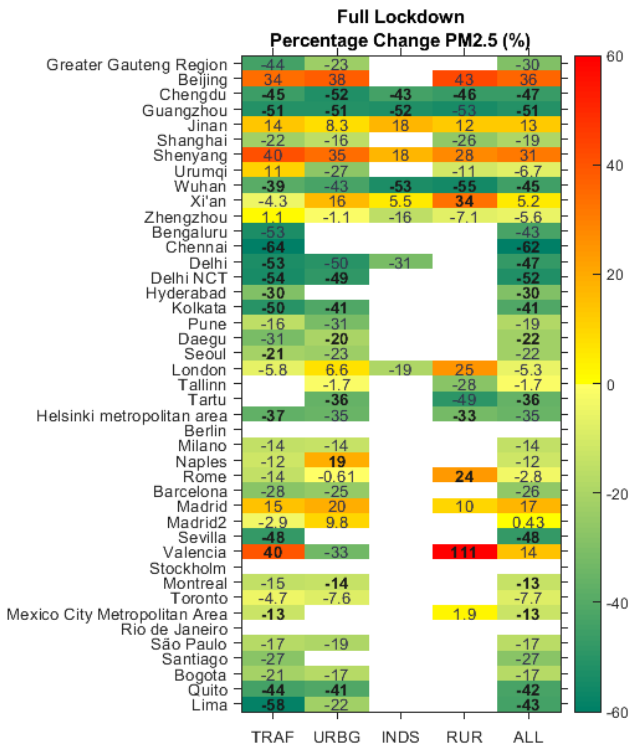


GAW

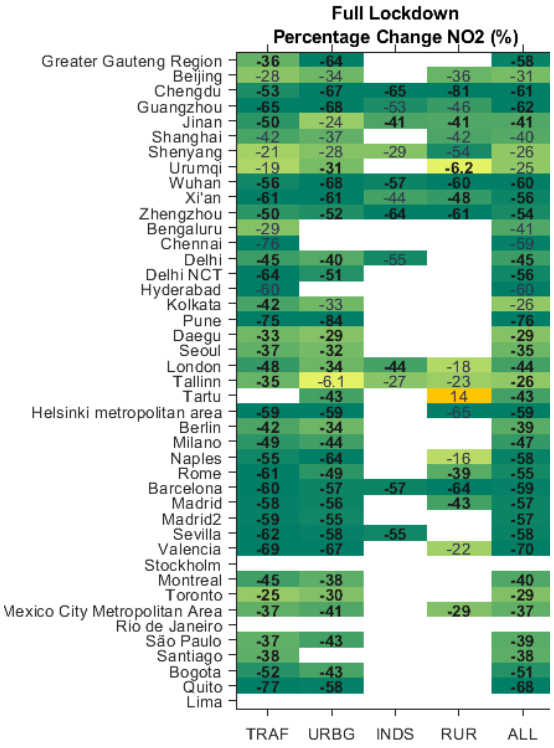
WMO

% Change in PM2.5, NO2 and O3 during full lockdown period at different station types

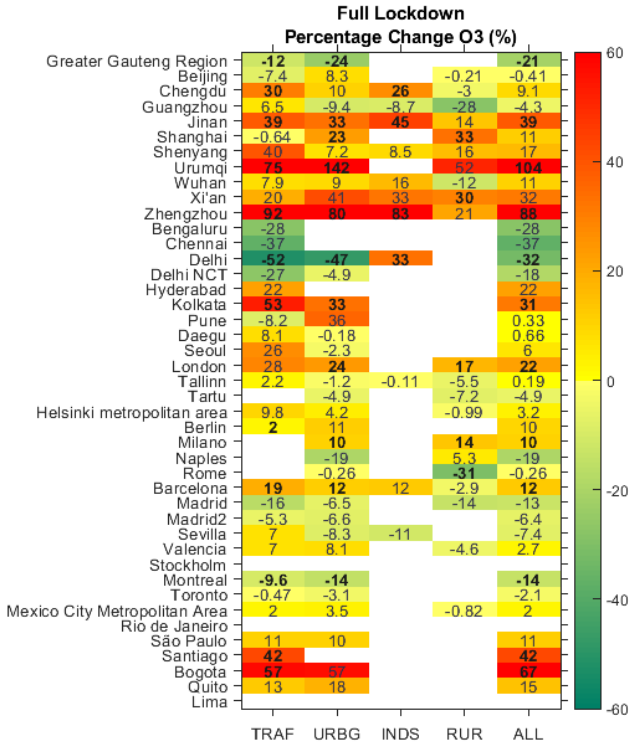
PM2.5



NO2



O3

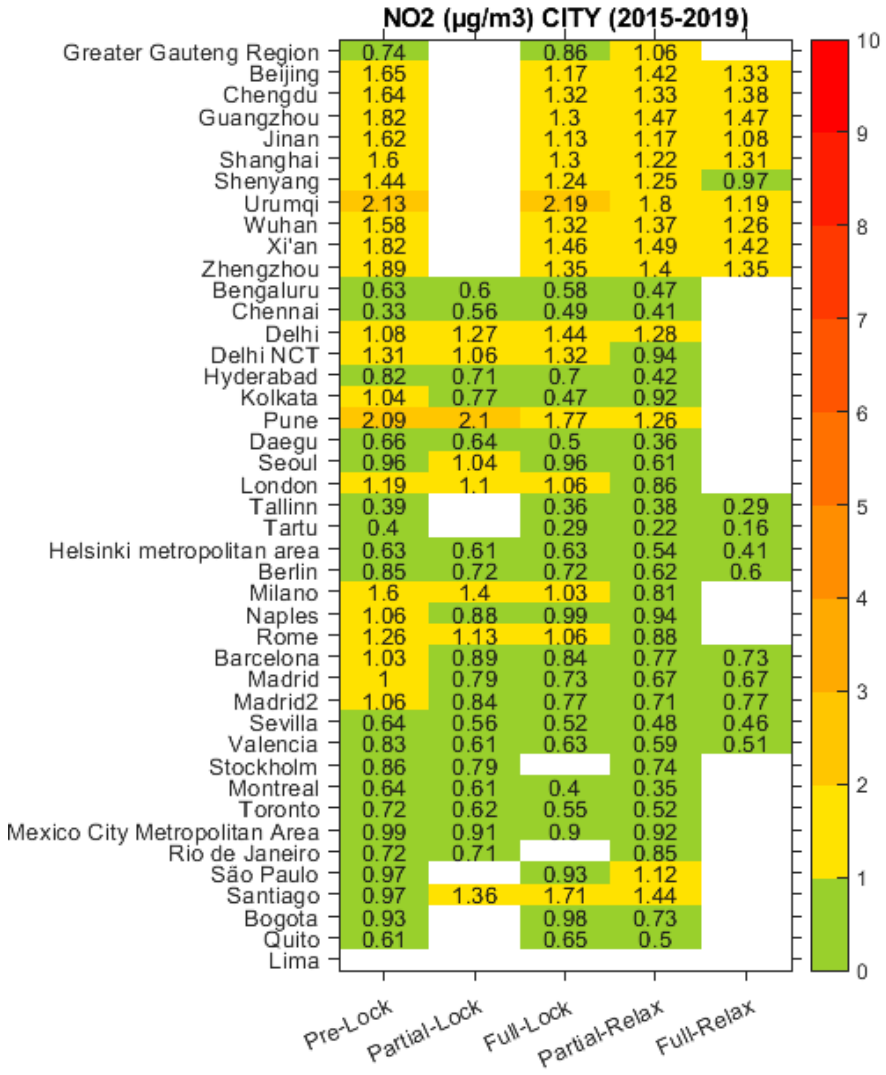


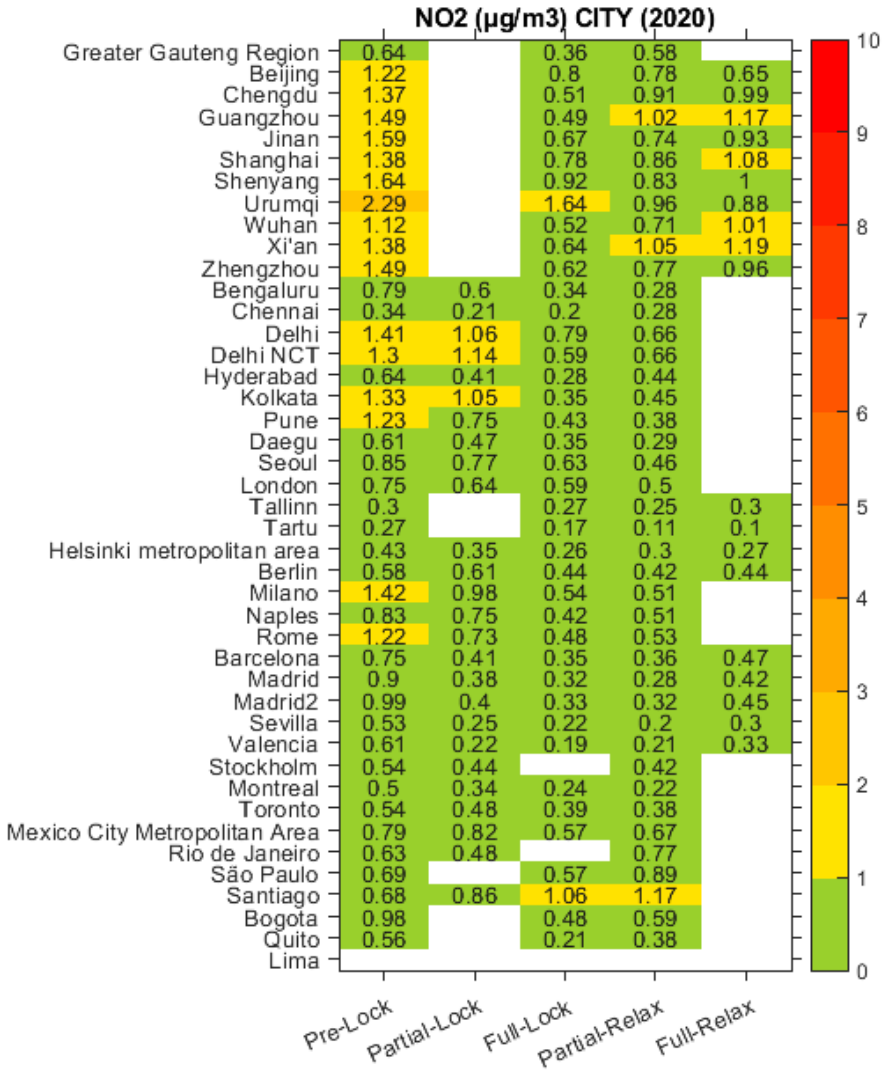
GAW

WMO

NO2 Exceedance > 40 ug/m3

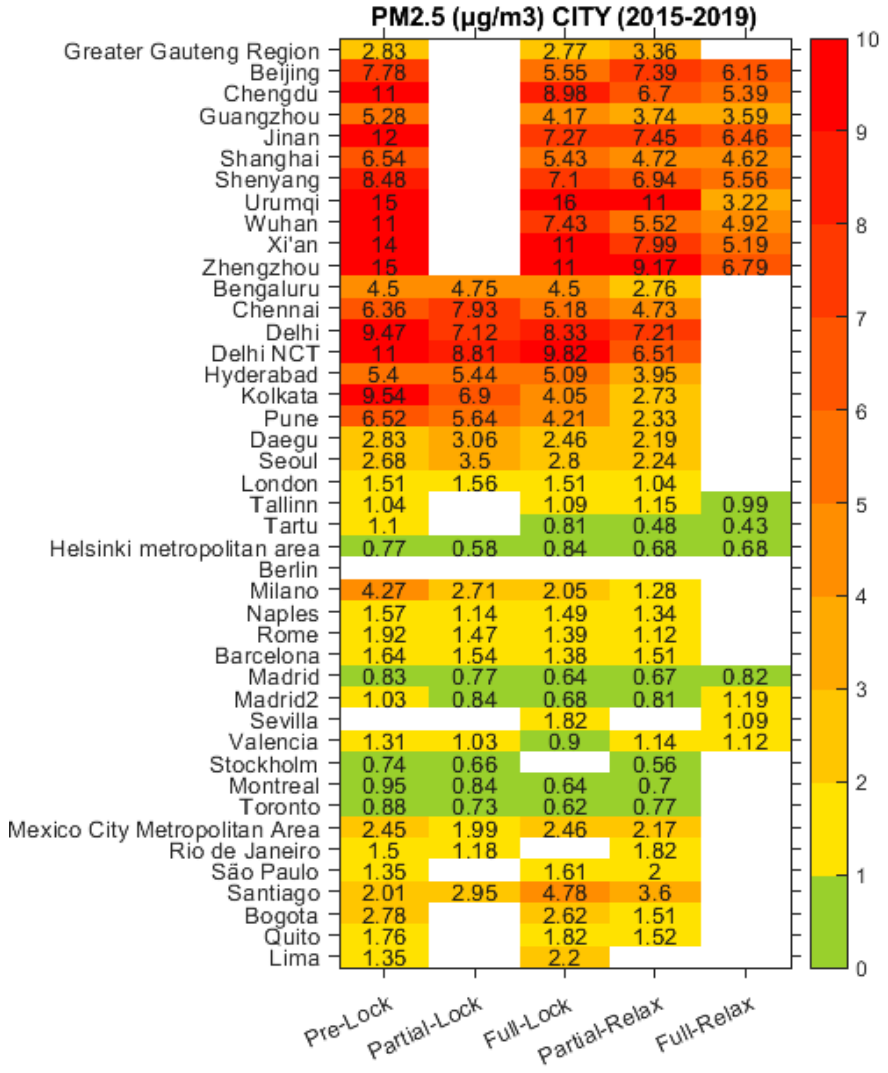
Improvement in air quality compared to WHO Guidelines

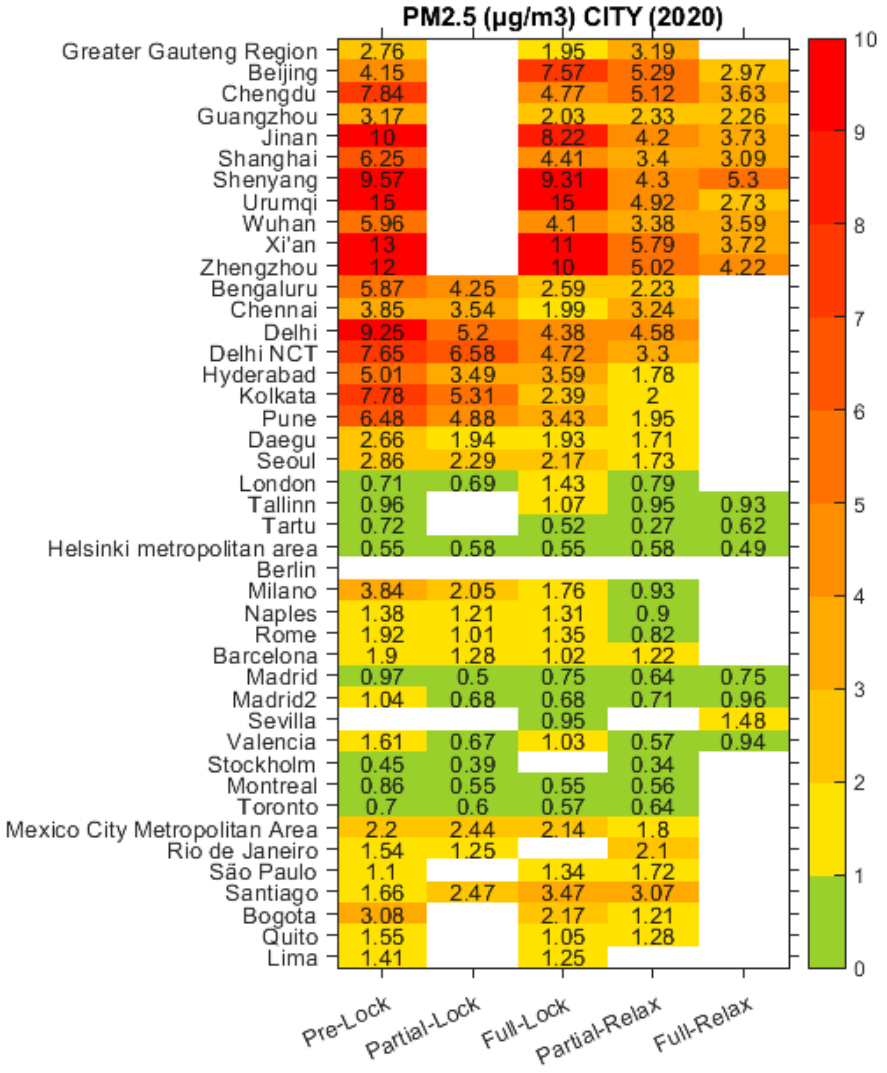




PM2.5 Exceedance > 10 ug/m3

Improvement in air quality compared to WHO Guidelines





Modelling study
UK case study

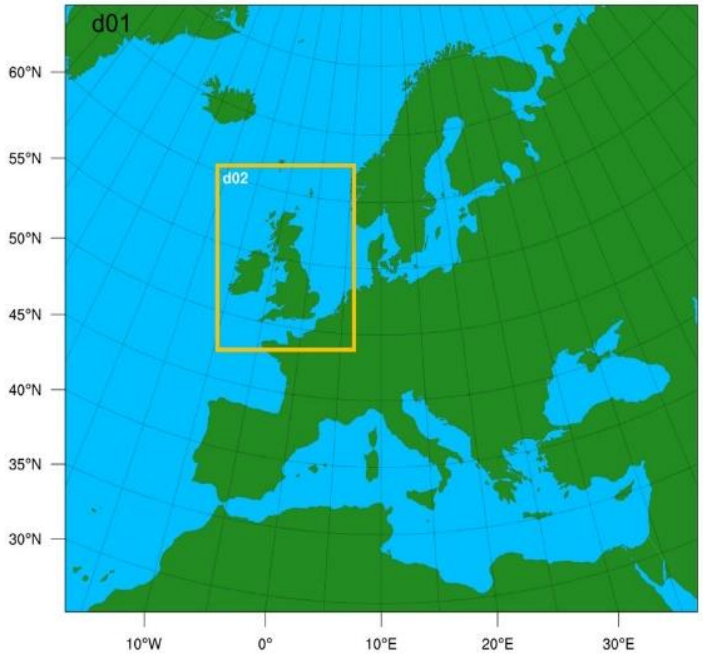
Analysis scenarios for the UK study

Baseline (BL) represents the UK and Europe emissions assuming no lockdown measures between **1 March to 26 April 2020**

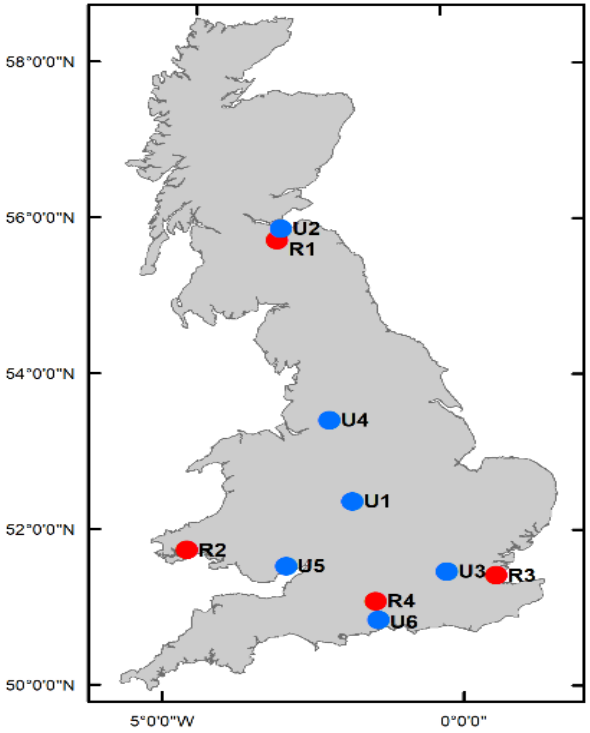
Scenario 1 is a plausible scenario to represents the overall comprehensive changes in emissions in the key sectors over the lockdown period of **24 March to 26 April**

Scenario 2 (S2) - sensitivity scenario to estimate the changes in air quality species attributable to **reductions only in road traffic emissions** over the lockdown period of **24 March to 26 April**

Approach – WRF-CMAQ modelling system



WRF/CMAQ model domain



Location of AURN measurement stations used for model evaluation

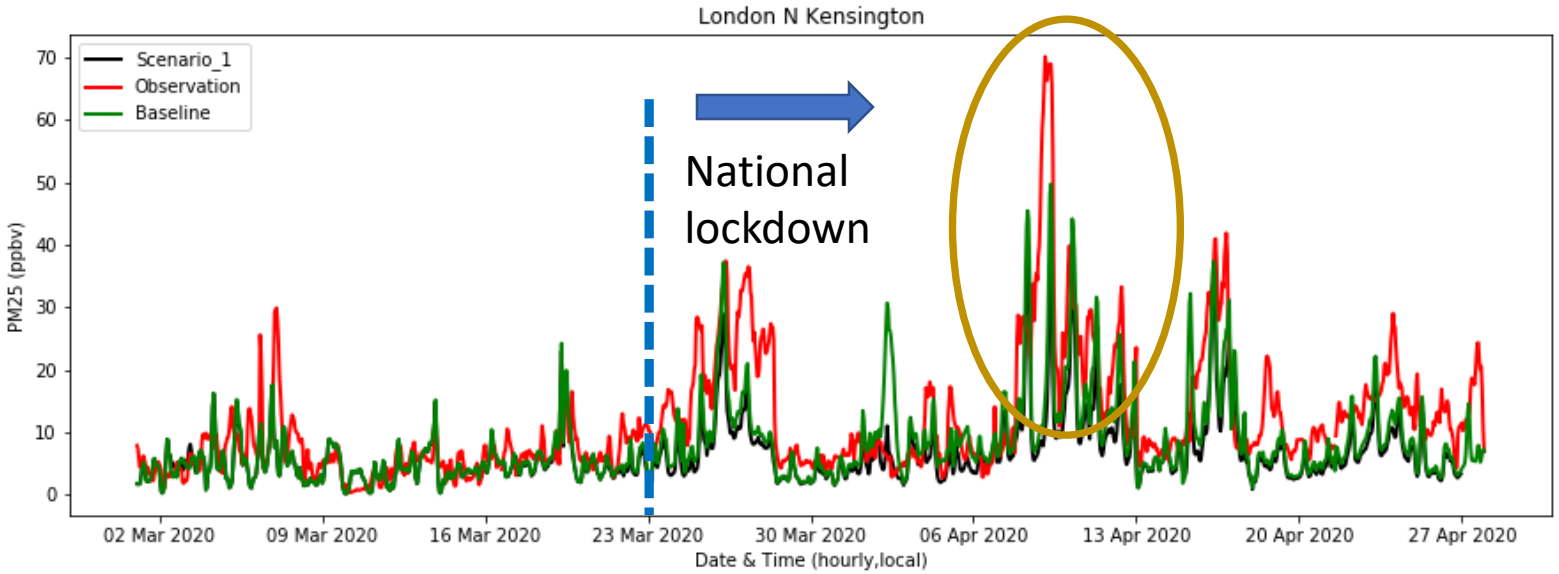
Evaluation statistics – Pre-lockdown Urban

Metric	NO2	NOx	O3	PM2.5	PM10
FAC2	0.906	0.877	0.983	0.906	0.899
MB	0.655	1.061	0.317	0.646	1.237
NMB	0.068	0.088	0.012	0.097	0.105
RMSE	4.868	7.218	5.514	2.893	5.117

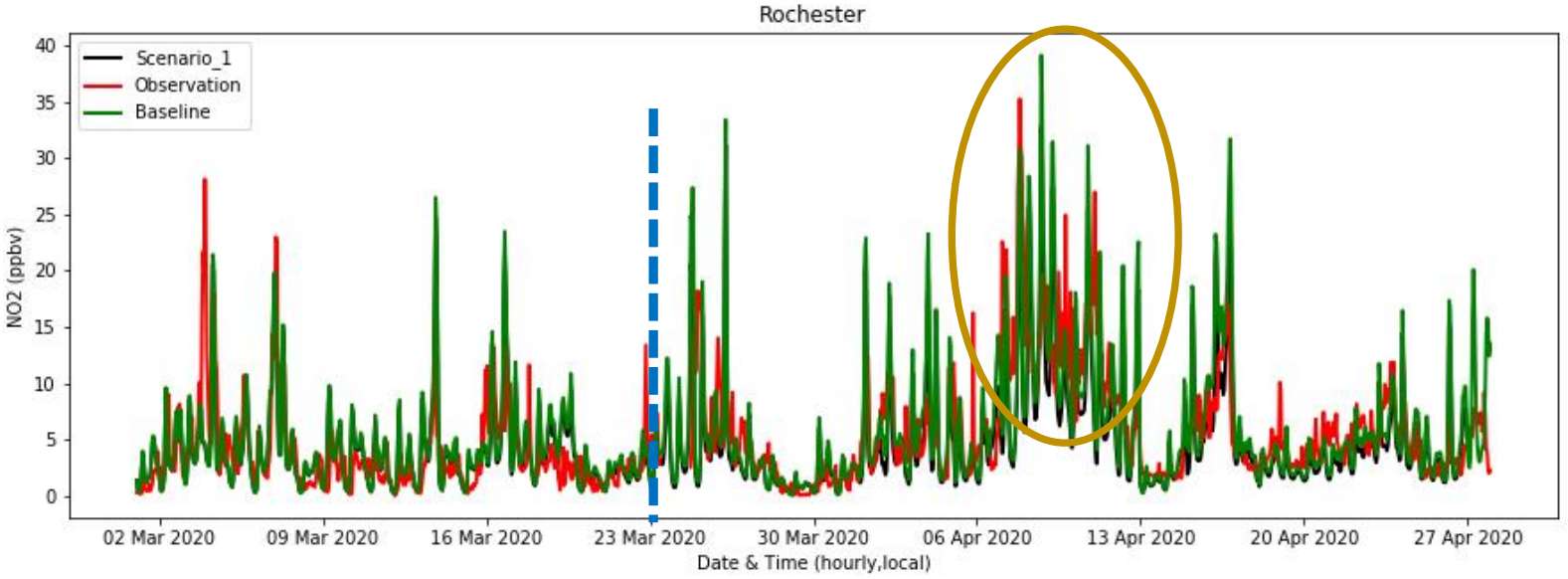
Station name	Type	Label
Auchencorth Moss	Rural	R1
Narberth	Rural	R2
Rochester Stoke	Rural	R3
Chilbolton Observatory	Rural	R4
Birmingham Acocks Green	Urban	U1
Edinburgh St Leonards	Urban	U2
London N. Kensington	Urban	U3
Manchester Piccadilly	Urban	U4
Newport	Urban	U5
Southampton Centre	Urban	U6

Baseline and Scenario 1 model predictions 01/03/2020 – 26/04/2020

PM2.5 London Urban BG station



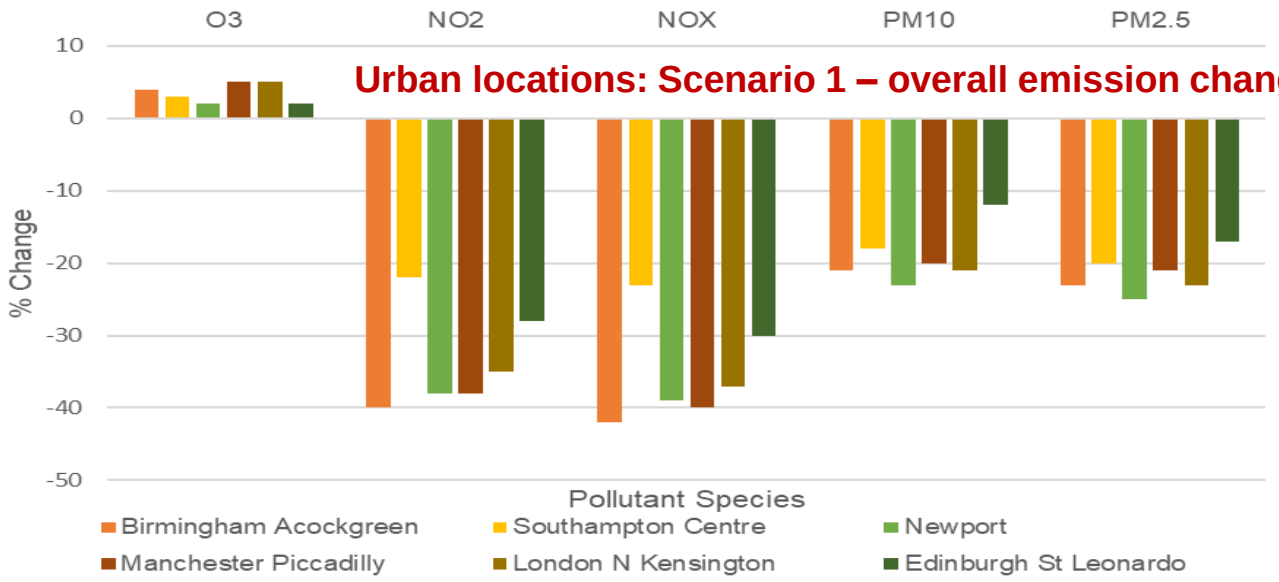
NO2 Rural BG station

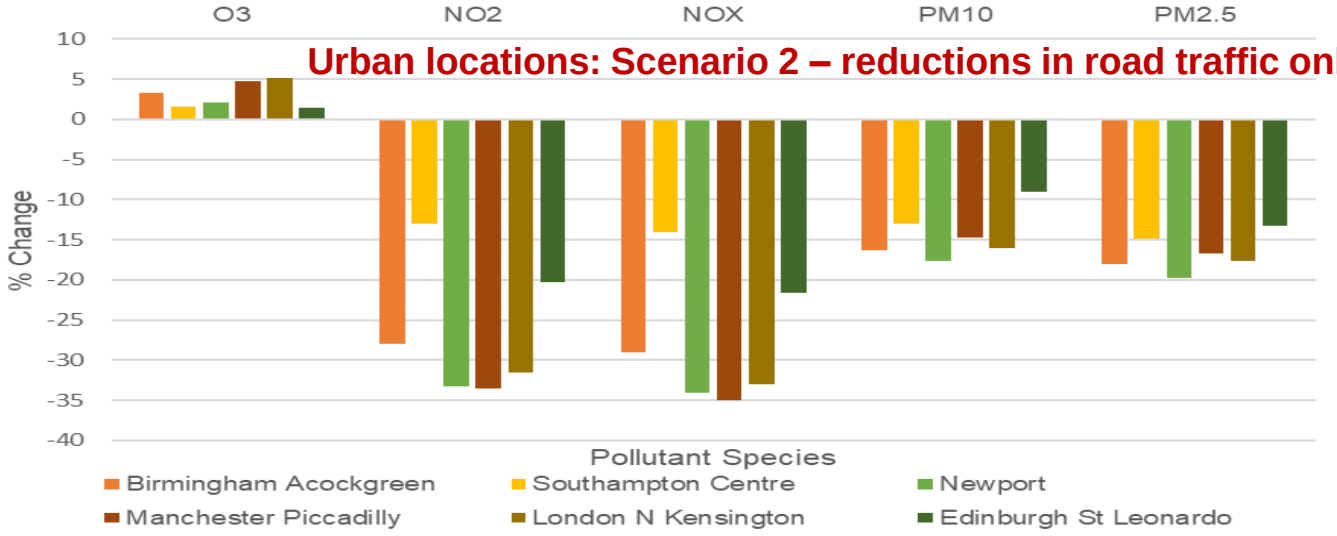


Predicted changes during the lockdown period at URBAN locations over the UK

Lockdown period 24 March to 26 April 2020

Most of the changes can be attributed to reductions in road traffic emissions

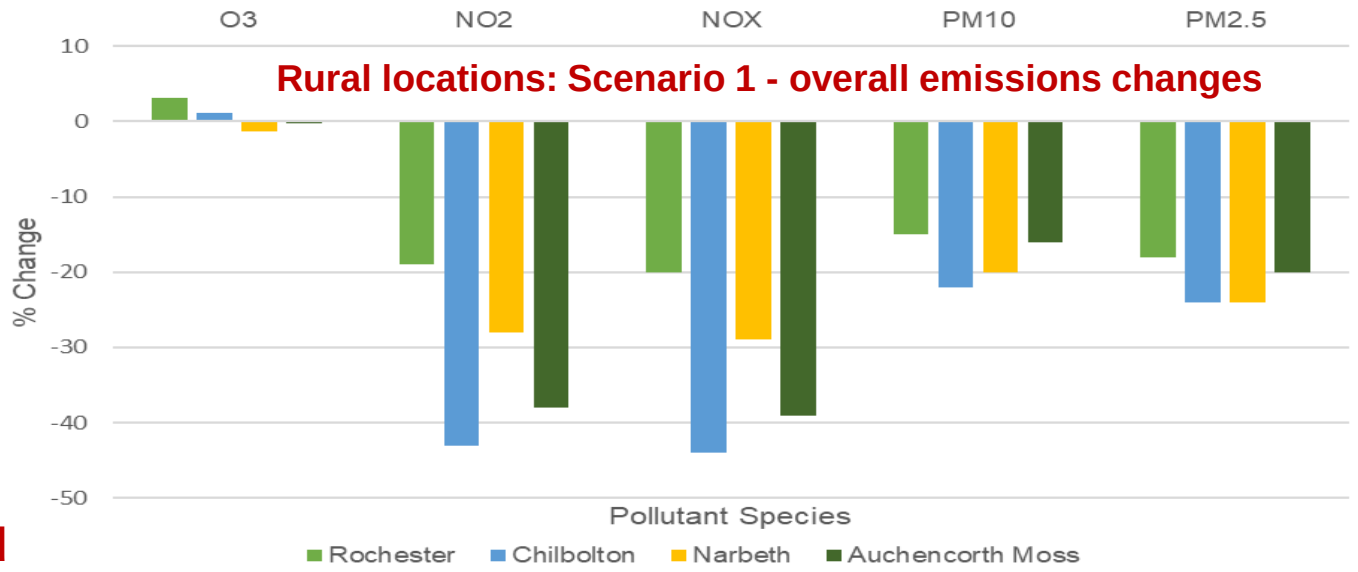


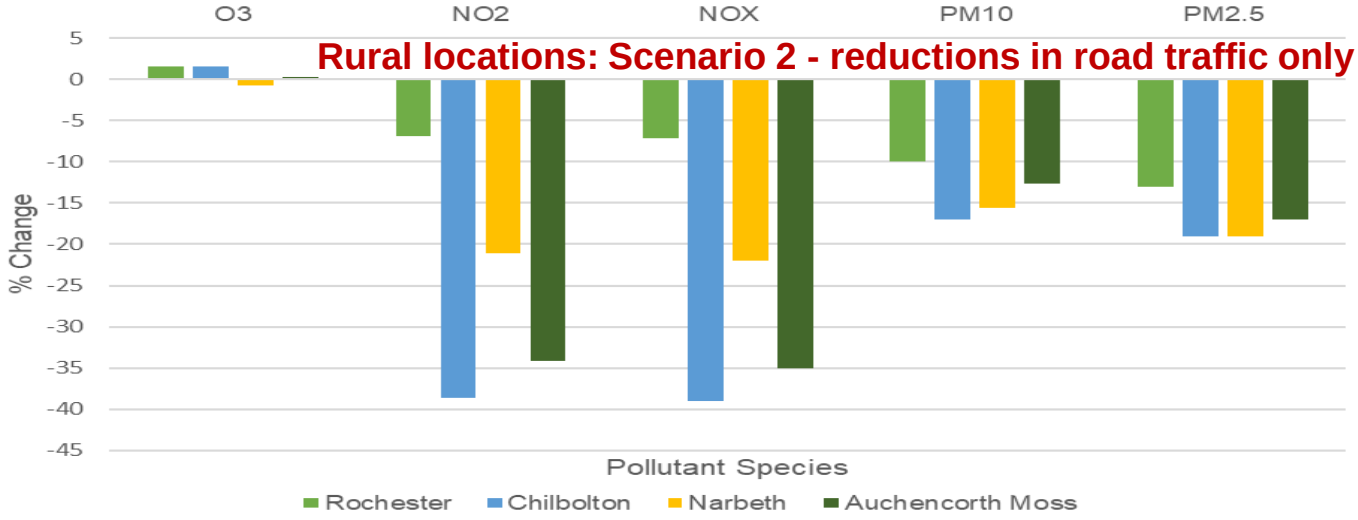


Predicted changes during the lockdown period at RURAL locations over the UK

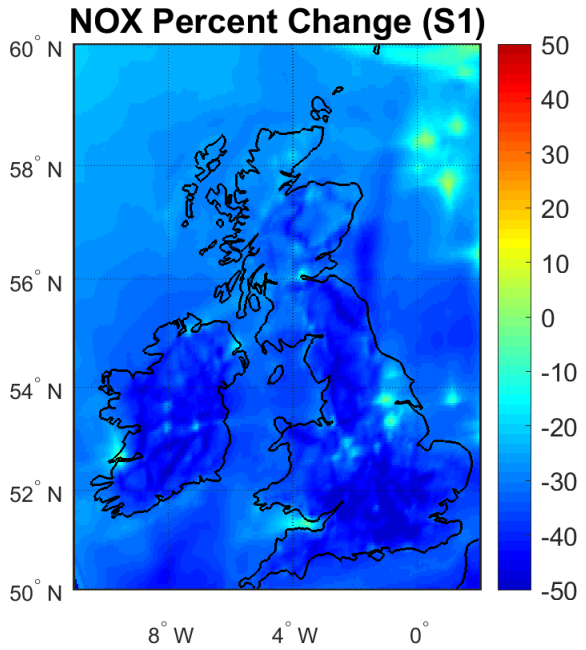
Lockdown period 24 March to 26 April 2020

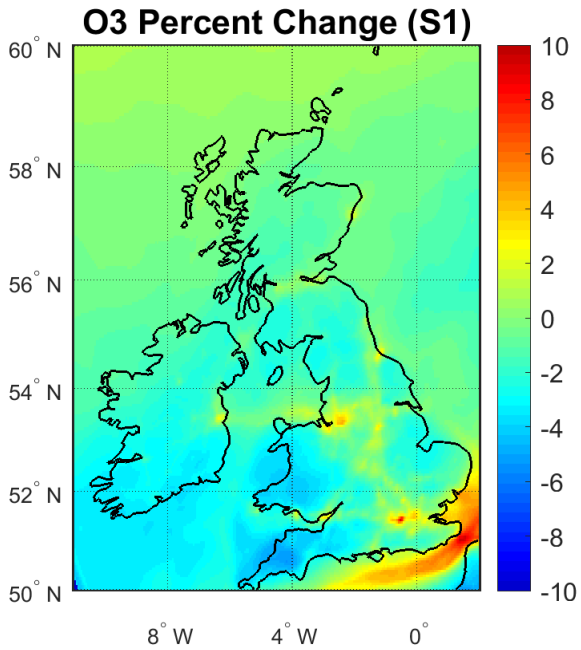
Most of the changes can be attributed to reductions in road traffic emissions

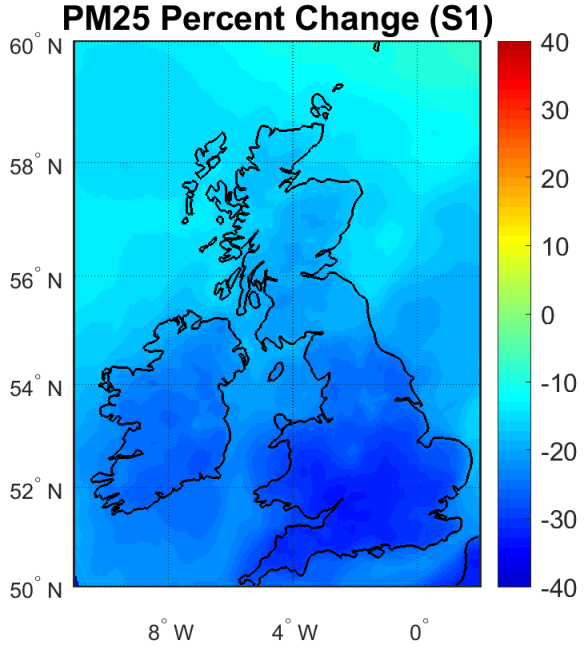




Predicted spatial changes in urban and rural locations – Scenario 1







Mean modelled percentage changes in NOx, O_3 and $PM_{2.5}$ over the UK during the lockdown period (24 March – 26 April 2020) based on Scenario 1 – overall emissions changes

Predicted percentage changes in air pollutant species averaged over UK regions during the lockdown

	Scenario 1 – Overall emissions changes						Scenario 2 – All transport emissions changes					
Regions	**NO2**	**NOx**	**O3**	**PM10**	**PM2.5**	**PMC**	**NO2**	**NOx**	**O3**	**PM10**	**PM2.5**	**PMC**
Scotland	-31	-31	-0.9	-12	-18	-1.2	-26	-27	-0.7	-12	-18	-0.4
N Ireland	-36	-36	-1.9	-16	-22	-3.3	-31	-31	-1.5	-15	-21	-2.3
NE England	-39	-40	-1.4	-16	-21	-4.9	-32	-32	-1.4	-15	-20	-3.2
NW England	-41	-41	-0.8	-20	-25	-7.3	-35	-36	-0.8	-18	-23	-4.6
Yorkshire/ Humberside	-32	-32	-1	-20	-25	-7.3	-26	-26	-1.1	-18	-24	-4.9
E Midlands	-36	-37	-1.2	-24	-29	-10.3	-32	-32	-1.2	-22	-27	-7.7
W Midlands	-39	-39	-1.5	-25	-30	-10	-34	-35	-1.5	-22	-28	-7
E England	-39	-40	-1	-24	-28	-10.9	-36	-37	-0.9	-22	-27	-8.7
London	-40	-41	2.1	-26	-30	-13.7	-37	-38	1.8	-24	-28	-9.2
SE England	-43	-44	-0.3	-26	-31	-12.2	-41	-41	-0.3	-24	-29	-9.5
SW England	-40	-41	-3.3	-26	-32	-10.8	-38	-38	-3	-24	-30	-8.9
Wales	-37	-37	-3.1	-24	-29	-7.3	-32	-32	-2.8	-22	-27	-5.2

Indication of spatial variations

Concluding remarks

- Changes in NO_2, NOx, $PM_{2.5}$. PM_{10}, PMC and O_3 for ~45 global cities
- Observational analysis shows a reduction up to 60% in NO2 and up to 40% in PM2.5 but with regional differences e.g. in some cities there is an increase in PM2.5
- Comparison with WHO Guidelines:
  - NO2 decreased and improved
  - PM2.5 improvement is smaller and still above guidelines for many regions, especially China, India, S Korea, Latin America
- Modelling analysis for UK predicts reductions in:
  - NO_2 of about 30-40% in urban and 20-40% in rural areas
  - PM ~ 20% in urban locations and ~15% in rural areas
  - PMC up to 14% reduction, mostly in urbanised areas
  - An increases in O_3 near airports and urban areas.
- Most of the changes during lockdown can be attributed to reduction in road traffic emissions

Where next?

- Analysis being extended to more global cities
- Analysis of PM species and changes in O3
- Process and modelling analysis is underway
- Linking changes in air pollutant species to emissions changes
- Identifying regional differences across the globe
- Lessons learnt for transitioning to lower air pollution emissions and improved air quality in global cities

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