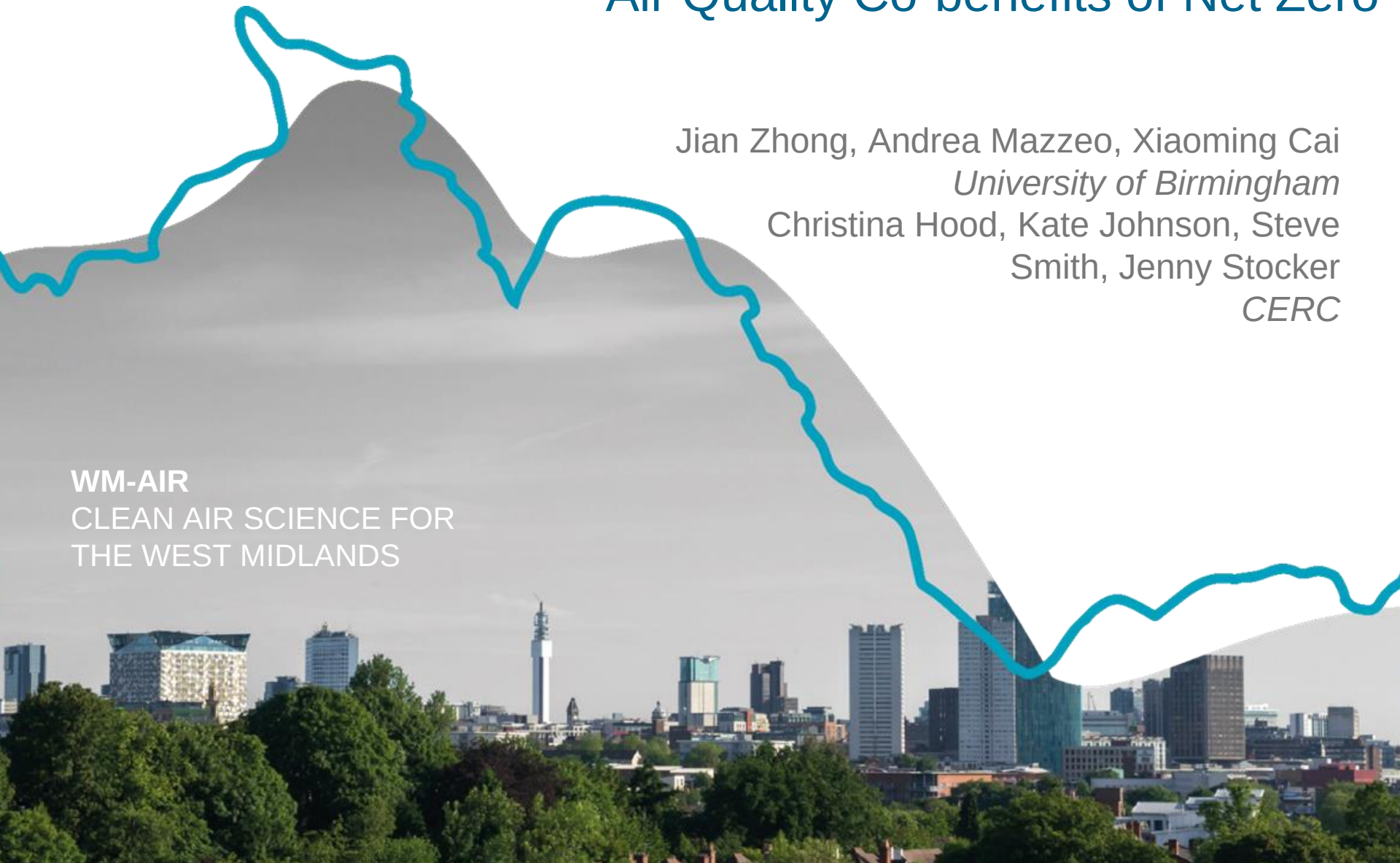
UNIVERSITY OF BIRMINGHAM | WM-AIR

Modelling Scenarios:
Air Quality Co-benefits of Net Zero

Jian Zhong, Andrea Mazzeo, Xiaoming Cai
University of Birmingham
Christina Hood, Kate Johnson, Steve Smith, Jenny Stocker
CERC

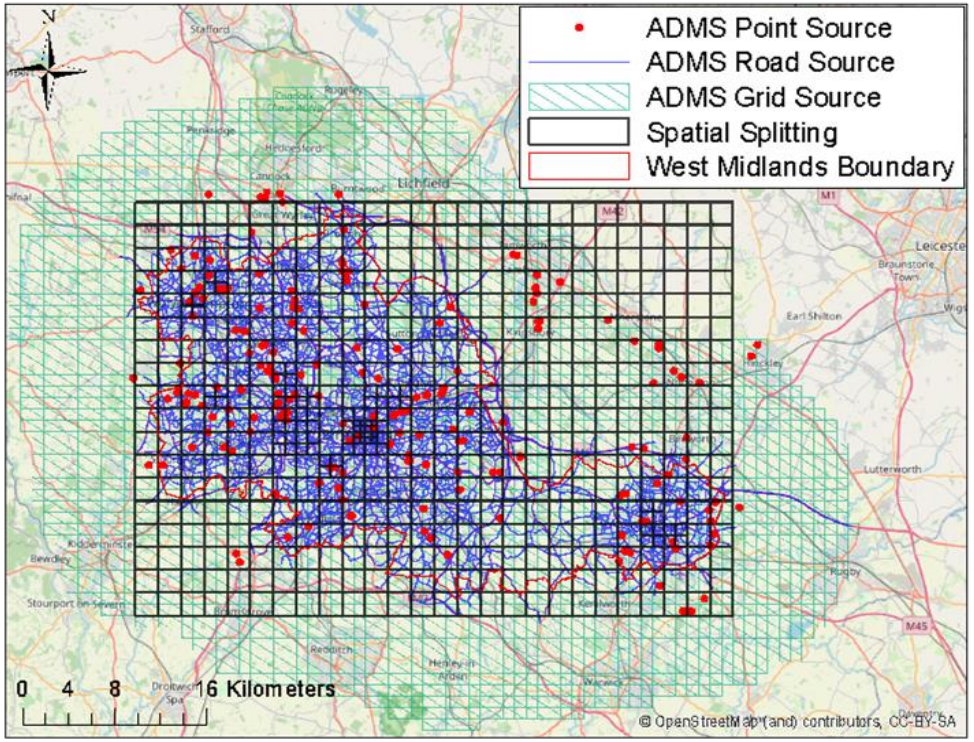
WM-AIR
CLEAN AIR SCIENCE FOR THE WEST MIDLANDS



WM-Air Local Modelling Approach

- ADMS-Urban developed in collaboration with CERC:

- Model baseline year 2016; updated to 2019. Meteorology, background levels as observed.
- Advanced canyon and urban canopy parameters calculated from explicit building footprints and heights
- Industrial emissions: NAEI, updated with BCC (Airviro) locations and stack properties
- Gridded emissions: NAEI, 1 km × 1 km resolution; 11 SNAP sectors; Modified sector 7 (Road Transport) based on explicit road adjustments (TfWM, BCC Prism, Remix)



(Zhong et al, 2021, Atmosphere)

Modelling Scenarios: Net Zero

- **2021 BAU** "Present day", no covid impacts on activity

- **2030 BAU** Business-as-usual: Anticipated emissions reductions in line with NECD commitments / 2019 Clean Air Strategy

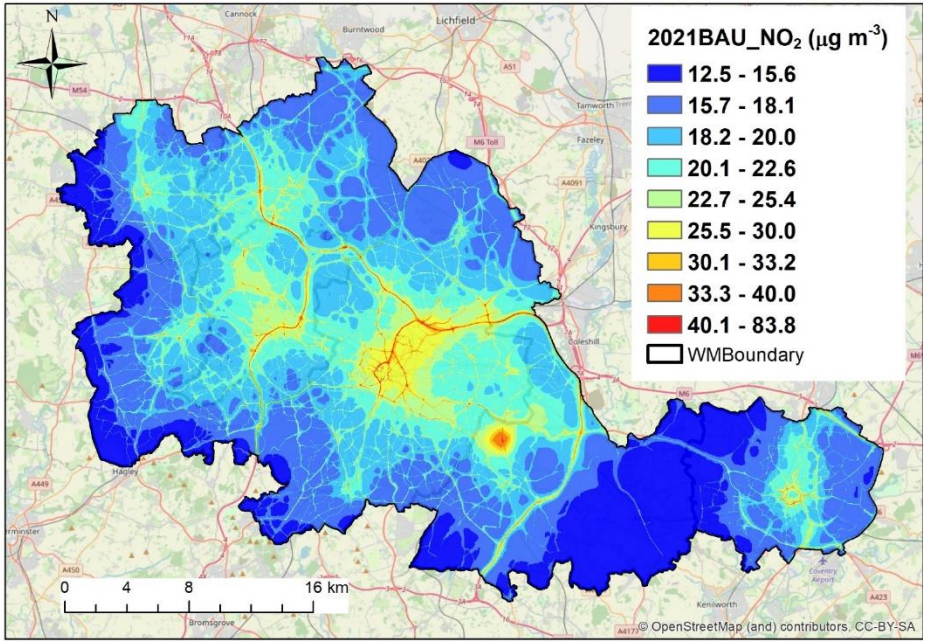
  https://www.eea.europa.eu/data-and-maps/data/necd-policies-and-measures-database

- **2030 Net Zero** Emission reductions estimated in line with the UK Net Zero Strategy for 2030

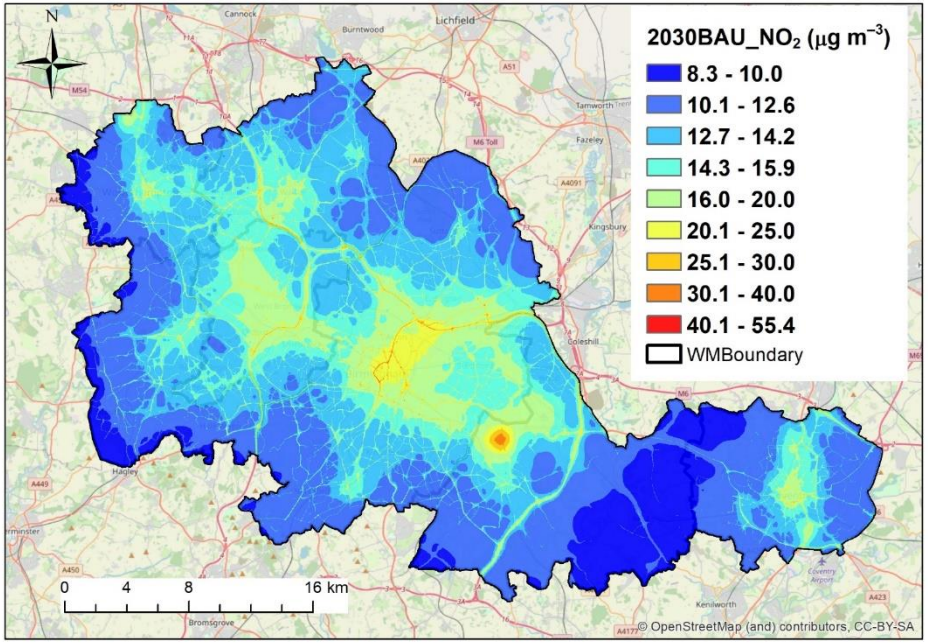
- **2030 EV** Transport-sector only changes in line with the above **2030 Net Zero** (24% car; 9% HGV; 25% bus/Coach=EV)

Changing Air Quality: Clean Air Strategy

2021 BAU_NO2

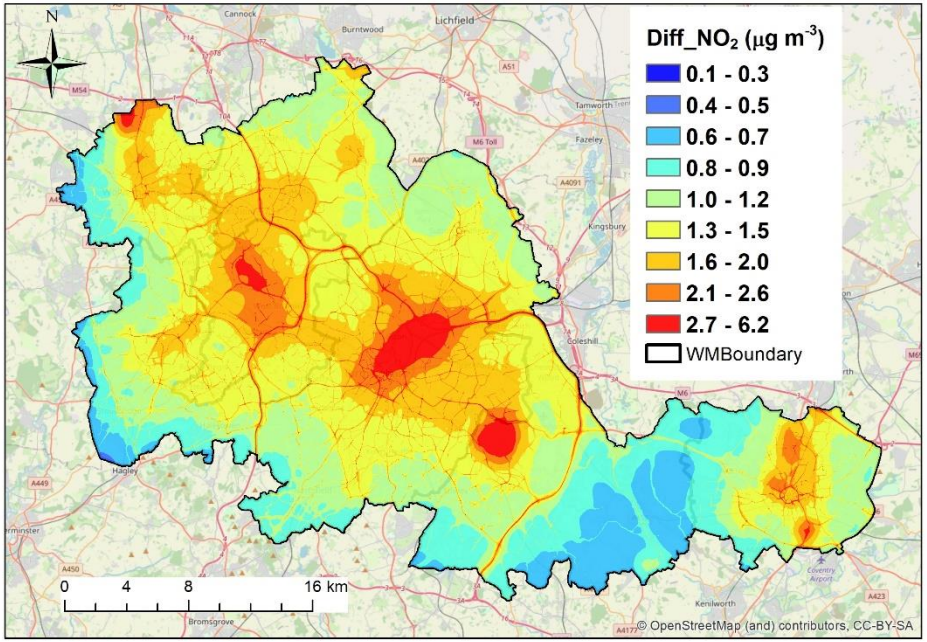


2030 BAU_NO2

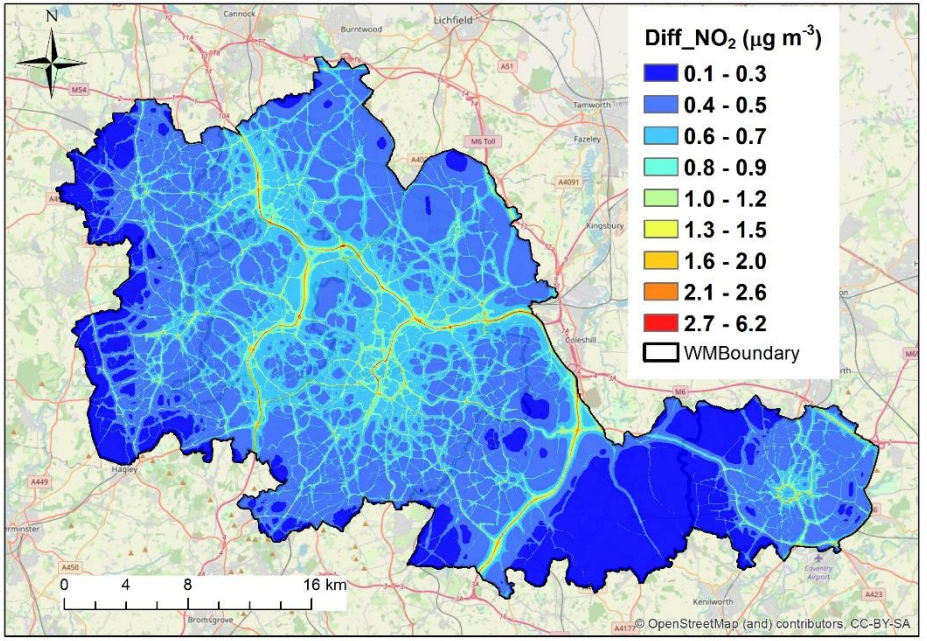


Air Quality Co-benefit: Net Zero

2030 BAU -2030 NZ



2030 BAU -2030 EV



Integrating modelled concentrations (to ward level) with WM-Air health and economic model:

Air Quality Life course Assessment Tool (AQ-LAT)

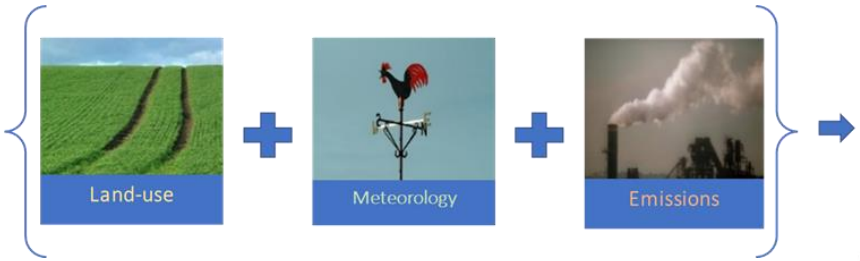
Opportunities: Local Modelling Scenarios

Scenario	Opportunities?
1. On-road vehicle fleet	Full fleet electrification; Bus electrification; Fleet changes due to CAZ; Pathway to Net Zero…
2. On-road vehicle behaviour	Consider speed reductions e.g. 20 mph on local roads and 60 mph on motorways…
3. Local Authority applications	CAZ; LTN; local-scale planning …
4. Transport mode change	Walk; Cycle; e-scooter…
5. Railway	Impact of railway emissions on air quality
6. Commercial combustion	Impact of primary emissions from commercial combustion; Decarbonisation…
7. Special event	Commonwealth Games; School vacation periods, public holiday periods…
…	

WMAir Regional Modelling – Model approach

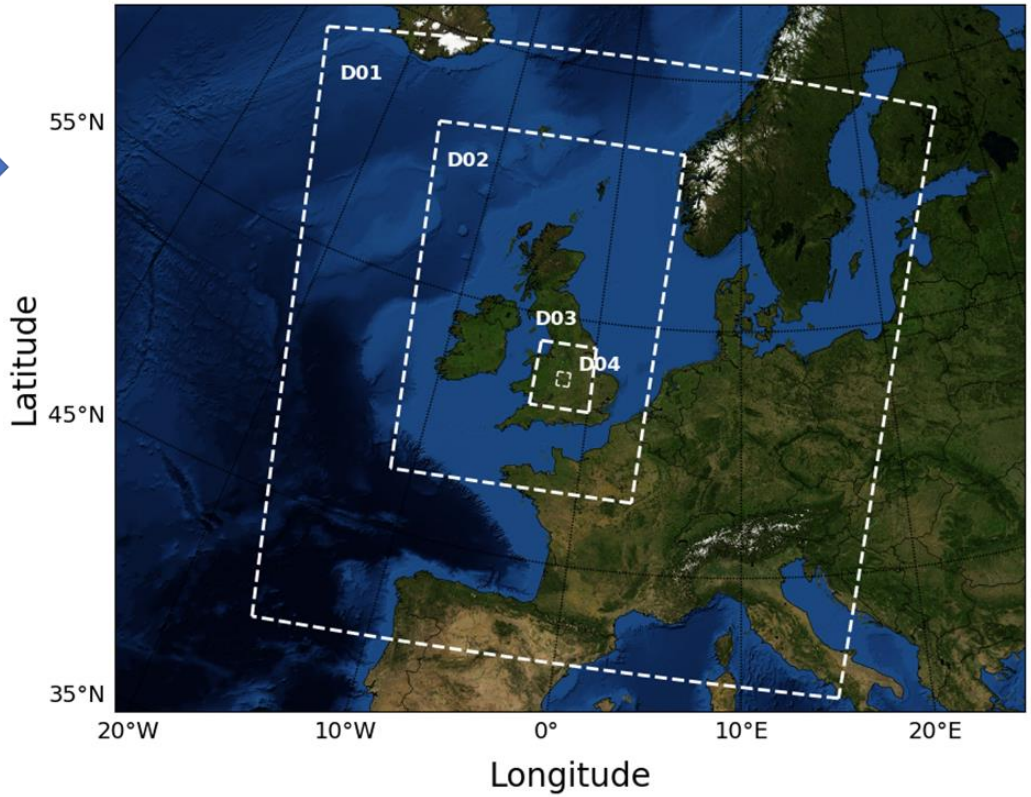
Regional modelling WRF-CMAQ:

- Representation of physical and chemical mechanisms acting in the low troposphere
- 51 species and more than 150 reactions are described (Carbon Bond 05)
- Model outputs validated against real-world data



Advantages of regional modelling:

- Wide spatial coverage (trans-boundary effects analysis)
- Air pollutant secondary processes included
- Impact of meteorological changes
- Impact of land use and natural emissions



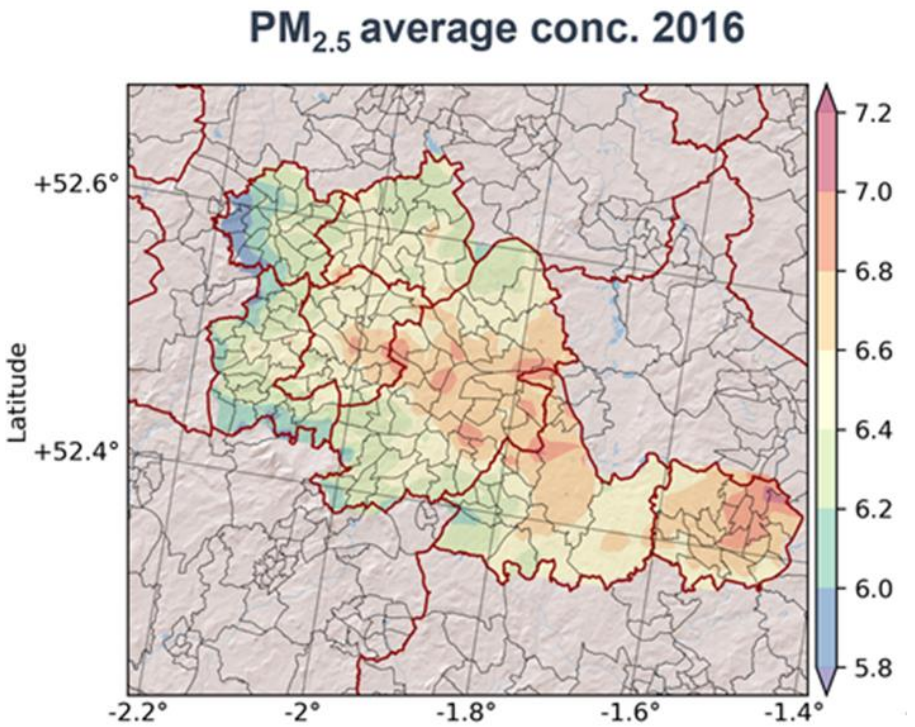
WMAir Regional Modelling –Scenarios design

Present scenarios for 2016[1]:

- Reduced anthropogenic emissions from:
- Domestic combustion (SNAP2)
- Road transport (SNAP7)
- Ammonia from agriculture (SNAP10)

Projected scenarios for 2030:

- Impact of **climate change**
- Impact of **mitigation policies:**
  - National Emission Ceiling directive 2018
  - Net Zero Strategy 2021
- **Combined effects** of climate change and mitigation policies



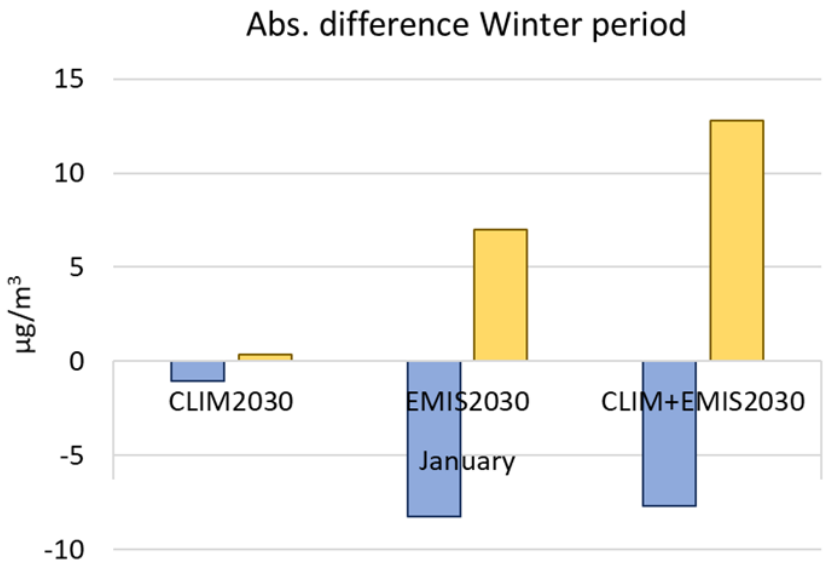
West Midlands domain 1x1 km

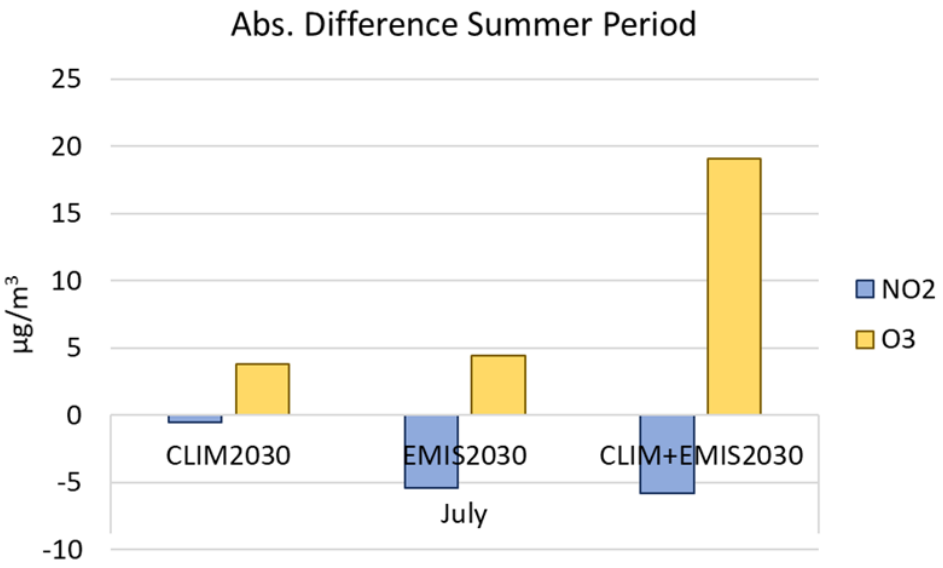
- **CLIM2030:** meteorology 2030 / anthropogenic emissions 2016
- **EMIS2030:** meteorology 2016 / anthropogenic emissions 2030
- **CLIM+EMIS2030:** meteorology 2030 / anthropogenic emissions 2030

[1] *Mazzeo et al., Atmosphere 2022, 13(3), 377 https://doi.org/10.3390/atmos13030377*

Future projections 2030: NO2 and O3

- Change in average concentrations of NO_2 and O_3 for winter and summer period of 2030





- **CLIM2030:** meteorology 2030 / anthropogenic emissions 2016
- **EMIS2030:** meteorology 2016 / anthropogenic emissions 2030
- **CLIM+EMIS2030:** meteorology 2030 / anthropogenic emissions 2030

Opportunities: possible regional modelling scenarios

Scenarios	Opportunities
1. Health impact	Impact of future changes in air pollution on mortality and morbidity changes (2030, 2050..)
2. Tree planting strategies	Strategies of tree planting (afforestation/reforestation) can have more or less impact on air quality
3. Industrial Combustion	NMVOCs from solvents account for 59% of primary emissions in the West Midlands. At national level 22% of NMVOCs and 22% of Sulphur dioxide comes from industrial combustion.
4. Energy production	Emissions of NO_X (22%), SO_2 (37%) are produced by energy production in the UK.
5. …	