



AIR QUALITY AND WEATHER

16TH FEBRUARY 2022

BLAISE KELLY

AIR QUALITY AND WEATHER



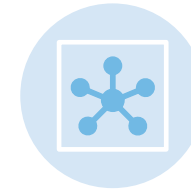
How does weather
affect air
pollution?



Where can we get
weather data?



How to join
monitoring data
and weather data



Chorlton Network
Meteo influence



Meteorological
normalisation

R

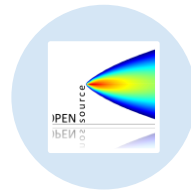
- Free and opensource
- Stable syntax
- Huge range of packages available
- Main packages used in this analysis shown on the right



tidyverse

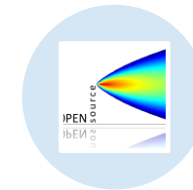


sf



worldmet

David Carslaw
University of York/Riccardo



openair

David Carslaw
University of York/Riccardo





HOW DOES WEATHER AFFECT AIR POLLUTION?

METEOROLOGICAL CONDITIONS

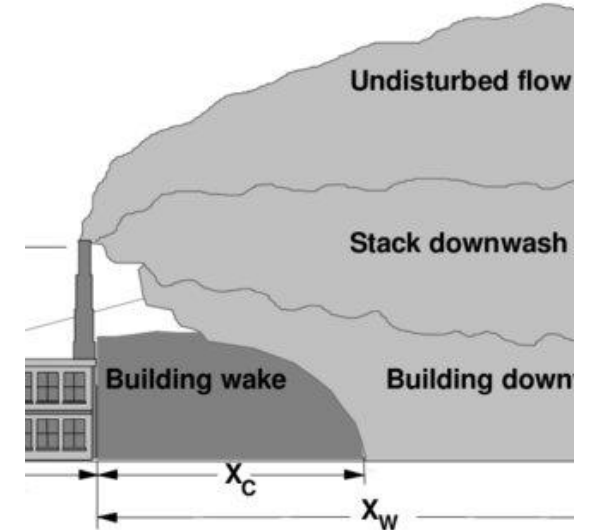
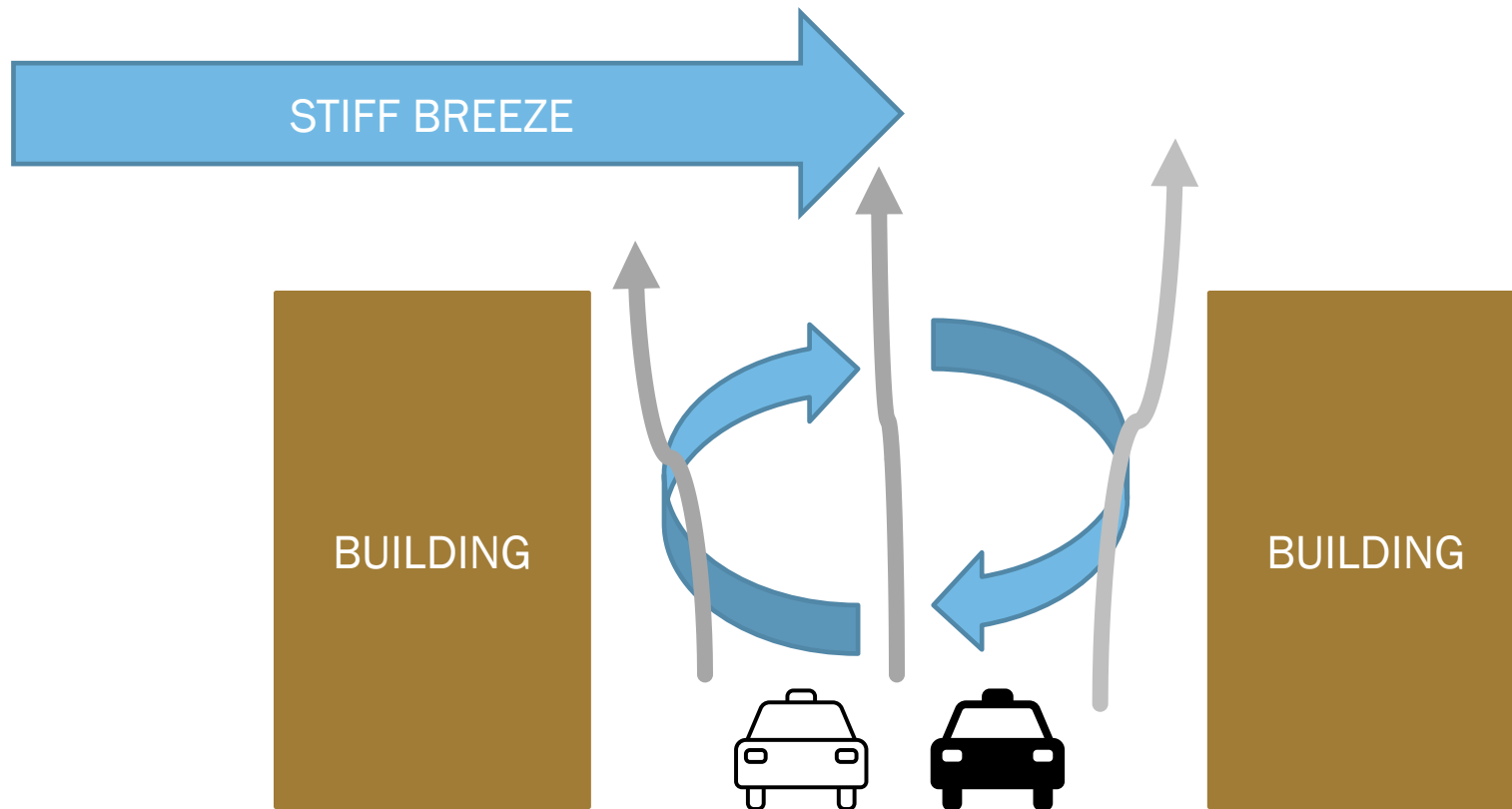
- Wind
- Air Temperature
- Boundary Layer
- Solar Irradiation

PROCESSES

- Thermal
- Chemical
- Mechanical

METEOROLOGICAL INFLUENCE WIND

- Recirculation currents cause concentrations to soar



Kukkonen, Jaakko. (1997). A DISPERSION
MODELLING SYSTEM FOR URBAN AIR POLLUTION.
10.13140/2.1.4386.6244.

METEOROLOGICAL INFLUENCE

BOUNDARY LAYER

CONVECTIVE MIXING

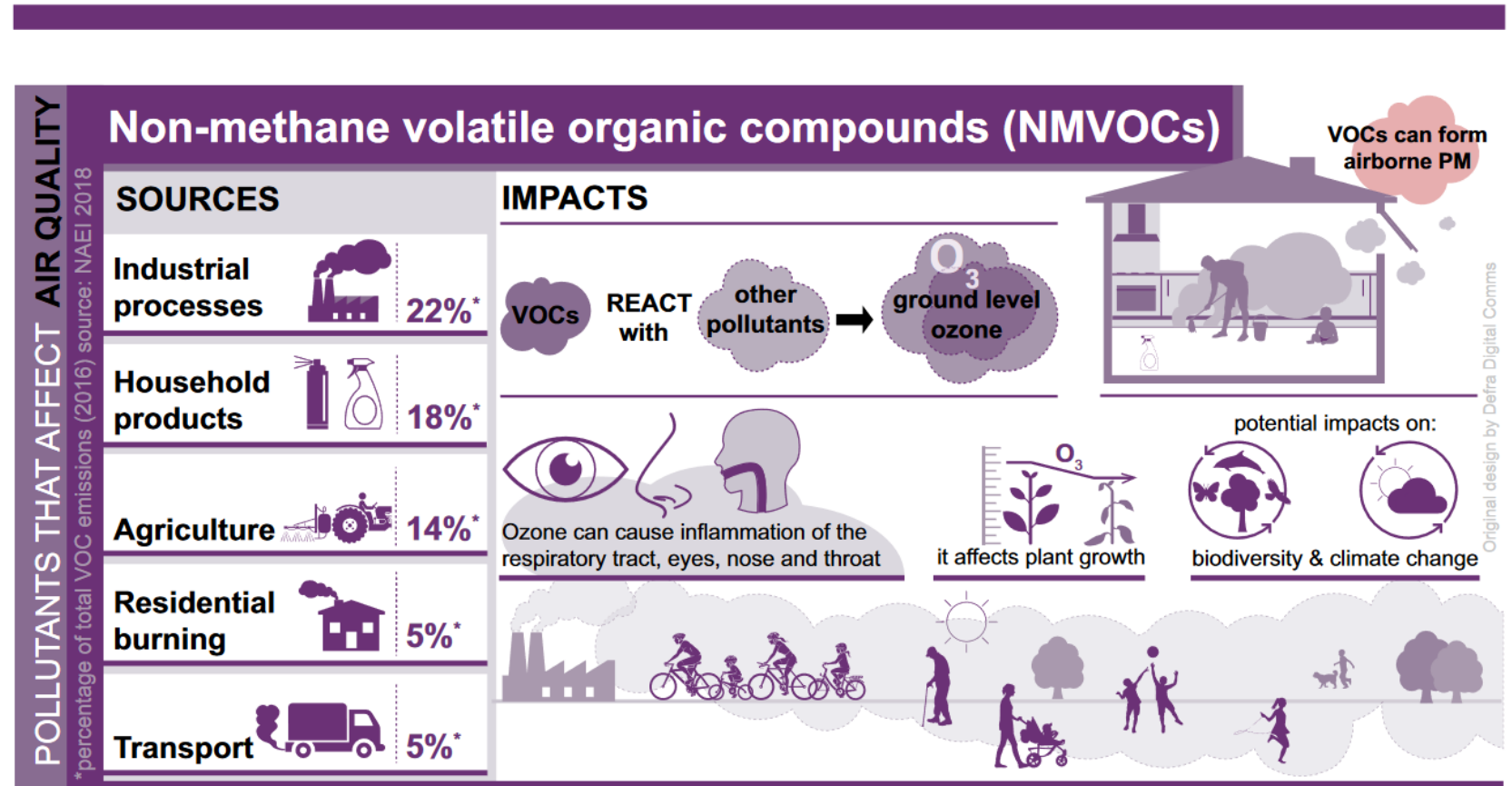
- Driven by the sun, limited to daylight hours
- Except – Inversions!
 - clear, windless sky and moist, damp ground
 - air close to the ground is cooler than the air higher above and becomes trapped
 - a fog also usually forms
 - Great smog of 1952 caused by an inversion

MECHANICAL MIXING

- Driven by wind (which is also driven by the sun)

METEOROLOGICAL INFLUENCE CHEMISTRY

- As soon as pollutants are emitted they are reacting with other elements
- Most common
 - NO_x to NO₂
- During 1st COVID lockdown O₃ increased as less NO_x to react with



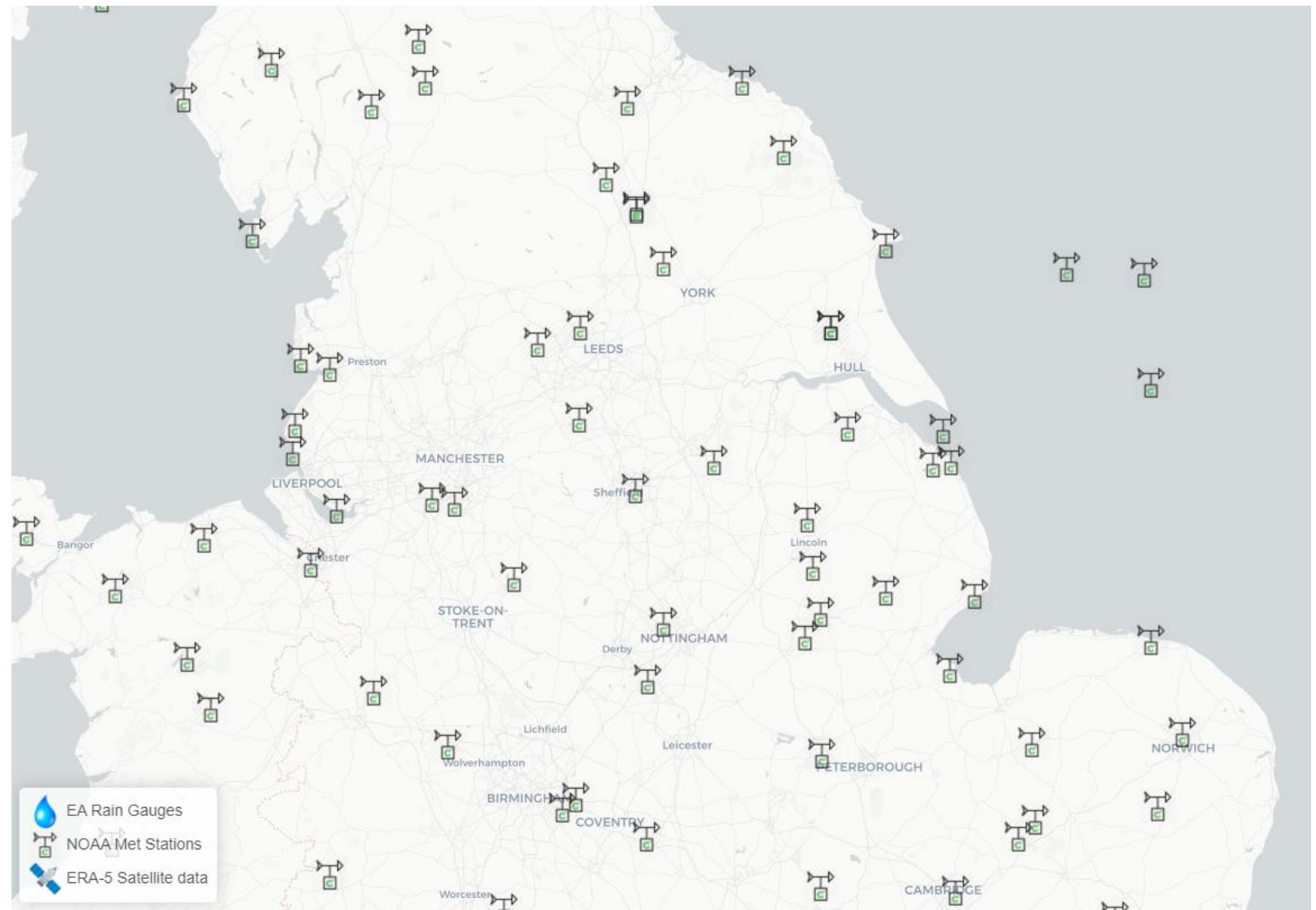
Source: Defra 2019 Clean Air Strategy

OPEN ACCESS METEO DATA

- NOAA Integrated Surface Database (ISD)
- 30,000+ meteorological stations around the world
- Data from 1930 to present
- Easy access has been made using the worldmet R package
- Wind Speed/Direction
- Air Temperature/Humidity
- Many sites have rain and cloud, although quality can be variable.

<https://www.ncei.noaa.gov/products/land-based-station/integrated-surface-database>

NOAA - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

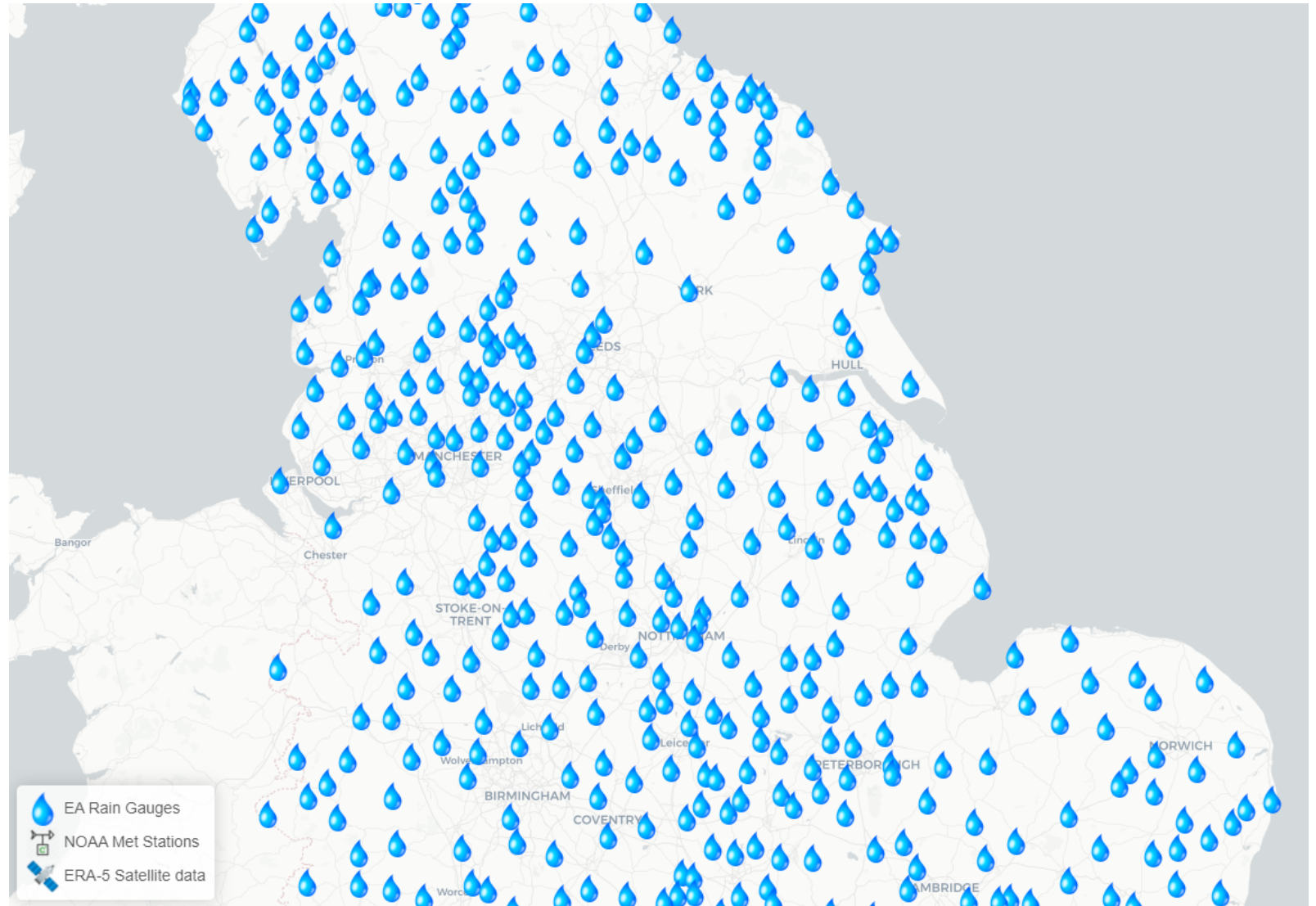


OPEN ACCESS METEO DATA

- 9000+ meteorological stations around the world
- Rain gauge data
- API only allows access for previous year
- Data back to year 2000 available on request
- Site codes can be confusing
- Other parameters such as river height also available

<https://environment.data.gov.uk/flood-monitoring/doc/rainfall>

EA – ENVIRONMENT AGENCY



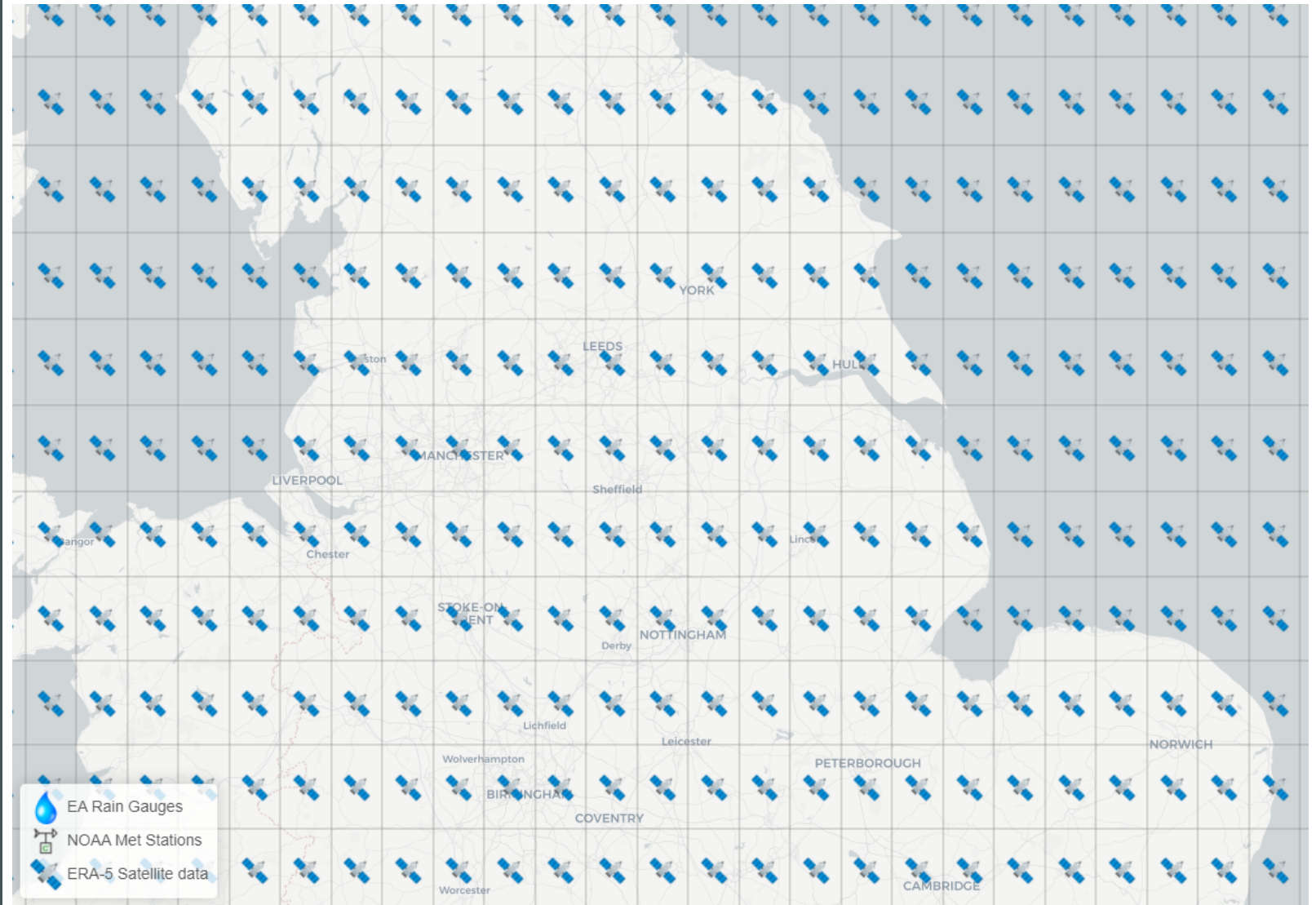
OPEN ACCESS METEO DATA

- ERA5 ~30km global
- ERA-Land ~9km, land only
- 280+ parameters available e.g. boundary layer height, solar radiation, cloud cover
- Model combining satellite observations with ground sites
- Access using ecmwfr R package, registration with Copernicus data store required and queuing system can be frustrating

<https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels?tab=overview>

<https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land?tab=overview>

ECMWF -EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS



JOINING AQ AND METEO

- Missing periods
- Mismatched time-series

AQ data – minute intervals

date	site_temp	site_rh	no2	o3	no	pm1	pm2.5
01/04/2021 00:00	12	66	20.01	41.76	0	9.26	23.68
01/04/2021 00:01	12	66	17.34	43.11	0	14.25	26.78
01/04/2021 00:02	12	66	24.64	35.96	2.21	14.25	27.45
01/04/2021 00:03	12	66	18.92	43.51	0	13.54	27.39
01/04/2021 00:04	12	66	21.22	50.51	5.51	14.96	34.14
01/04/2021 00:05	12	66	21.62	44.16	0	14.25	26.78
01/04/2021 00:06	12	66	22.56	46.96	6.26	14.25	27.51
01/04/2021 00:07	12	66	30.32	34.46	23.14	14.96	27.51
01/04/2021 00:08	12	66	19.2	49.96	0	14.96	28.11
01/04/2021 00:09	12	67	17.17	47.91	0	11.4	24.82
01/04/2021 00:10	12	67	20.97	43.81	0	12.11	26.2
01/04/2021 00:11	12	67	28.52	28.61	179.44	13.54	27.04
01/04/2021 00:12	12	67	23.88	41.41	7.01	14.25	27.09
01/04/2021 00:13	12	67	19.03	48.76	0	14.25	25.71
01/04/2021 00:14	12	67	17.22	49.16	0	15.68	27.09
01/04/2021 00:15	12	67	19.5	47.66	0	12.11	24.7
01/04/2021 00:16	12	67	22.41	47.26	0.65	14.25	27.21
01/04/2021 00:17	12	67	22.86	45.91	2.42	12.83	26.43
01/04/2021 00:18	12	67	17.94	52.01	0	11.4	23.15
01/04/2021 00:19	12	67	17.03	54.46	0	12.11	25.37
01/04/2021 00:20	11	67	15.81	57.51	0	8.55	17.8
01/04/2021 00:21	11	67	15.84	57.26	0	9.98	19.46
01/04/2021 00:22	11	67	15.34	55.11	0	13.54	25.42
01/04/2021 00:23	11	67	17.53	49.61	0	11.4	22.22
01/04/2021 00:24	11	68	15.27	52.86	0	10.69	22.01
01/04/2021 00:25	11	68	17.01	48.96	0	9.98	22.62



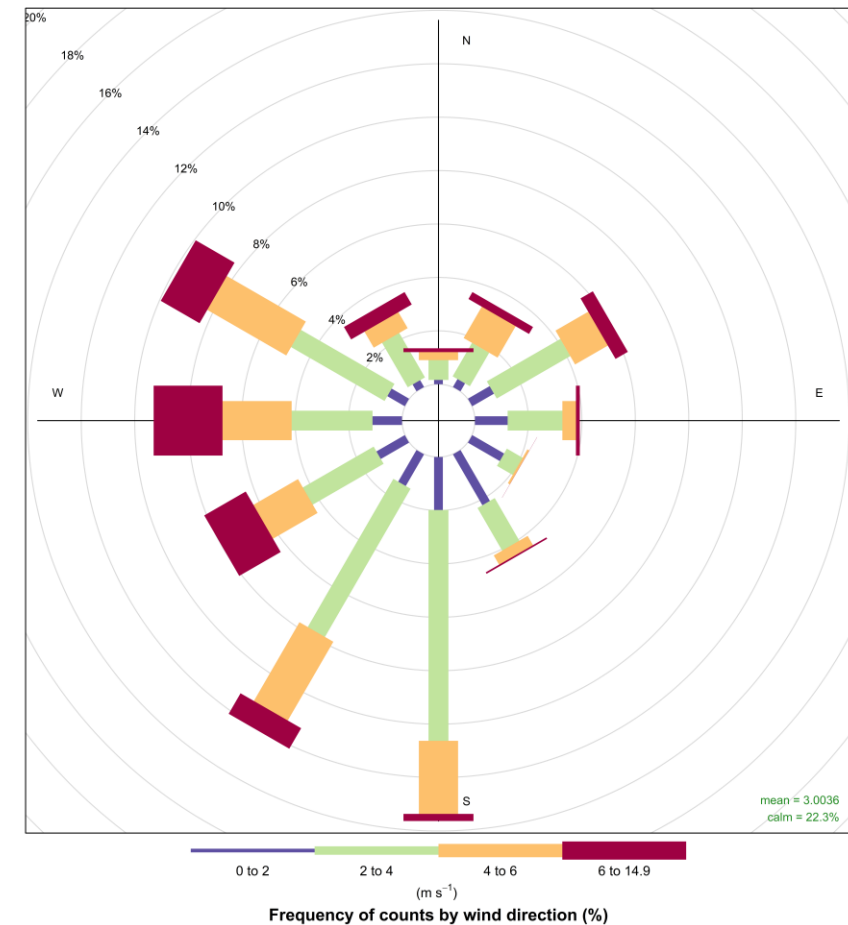
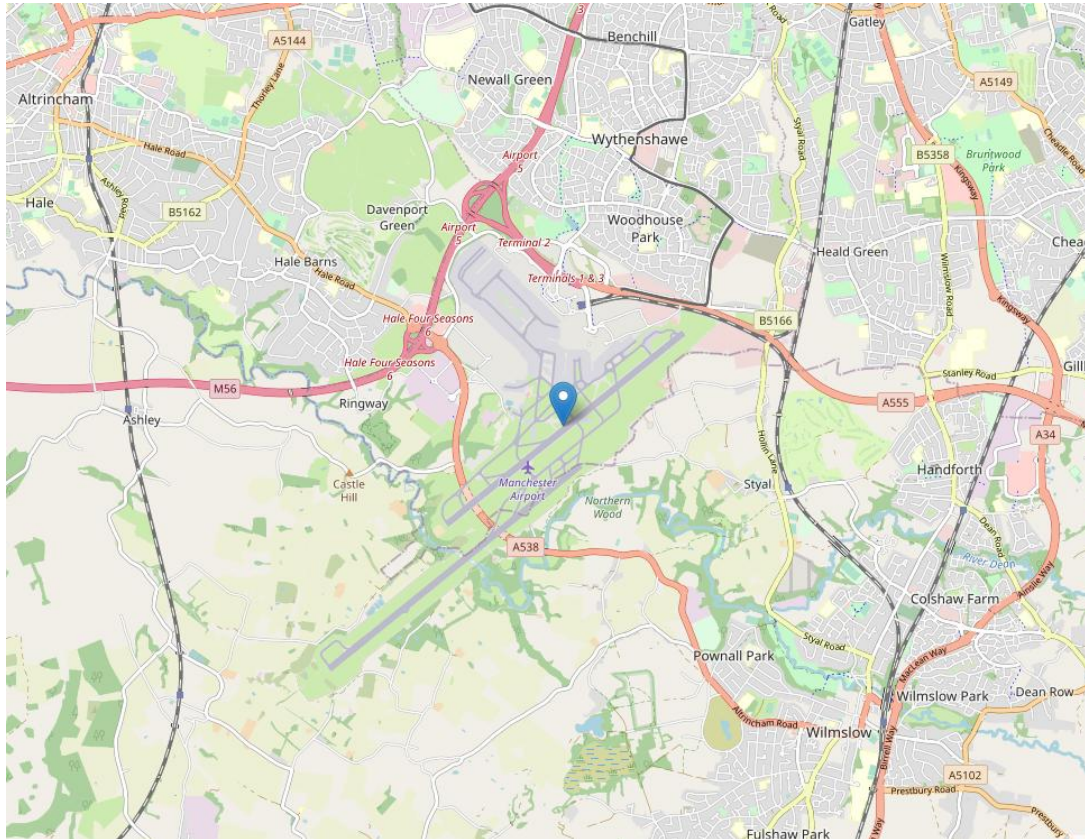
Meteo data – half hourly 20 past and ten to hour

date	code	station	elev	ws	wd	air_temp	atmos_pres
01/01/2021 00:20	033340-99999	MANCHESTER, UK	78.33	1	270	0	NA
01/01/2021 00:50	033340-99999	MANCHESTER, UK	78.33	1.5	270	0	NA
01/01/2021 01:20	033340-99999	MANCHESTER, UK	78.33	1.5	290	0	NA
01/01/2021 01:50	033340-99999	MANCHESTER, UK	78.33	1	280	0	NA
01/01/2021 02:20	033340-99999	MANCHESTER, UK	78.33	0.5	240	0	NA
01/01/2021 02:50	033340-99999	MANCHESTER, UK	78.33	0.5	NA	0	NA
01/01/2021 03:20	033340-99999	MANCHESTER, UK	78.33	1.5	300	0	NA
01/01/2021 03:50	033340-99999	MANCHESTER, UK	78.33	1	NA	0	NA
01/01/2021 04:20	033340-99999	MANCHESTER, UK	78.33	1.5	310	0	NA
01/01/2021 04:50	033340-99999	MANCHESTER, UK	78.33	0.5	NA	0	NA
01/01/2021 05:20	033340-99999	MANCHESTER, UK	78.33	1	NA	0	NA
01/01/2021 05:50	033340-99999	MANCHESTER, UK	78.33	0.5	220	0	NA
01/01/2021 06:20	033340-99999	MANCHESTER, UK	78.33	1	270	0	NA
01/01/2021 06:50	033340-99999	MANCHESTER, UK	78.33	0.5	NA	0	NA
01/01/2021 07:20	033340-99999	MANCHESTER, UK	78.33	0.5	NA	0	NA
01/01/2021 07:50	033340-99999	MANCHESTER, UK	78.33	0.5	NA	0	NA
01/01/2021 08:20	033340-99999	MANCHESTER, UK	78.33	1	220	0	NA
01/01/2021 08:50	033340-99999	MANCHESTER, UK	78.33	1	250	0	NA
01/01/2021 09:20	033340-99999	MANCHESTER, UK	78.33	1	NA	0	NA
01/01/2021 09:50	033340-99999	MANCHESTER, UK	78.33	2.1	310	1	NA
01/01/2021 10:20	033340-99999	MANCHESTER, UK	78.33	2.1	310	1	NA
01/01/2021 10:50	033340-99999	MANCHESTER, UK	78.33	2.6	310	2	NA
01/01/2021 11:20	033340-99999	MANCHESTER, UK	78.33	0.5	NA	2	NA
01/01/2021 11:50	033340-99999	MANCHESTER, UK	78.33	3.1	310	3	NA
01/01/2021 12:20	033340-99999	MANCHESTER, UK	78.33	3.6	320	3	NA
01/01/2021 12:50	033340-99999	MANCHESTER, UK	78.33	3.6	320	3	NA

Use 'openair' timeAverage function to aggregate the time-series to same period and left_join from 'dplyr' which matches dates

METEO DATA USED FOR WIND/TEMPERATURE ANALYSIS

- Data from Manchester Airport for full year of 2021 from NOAA ISD accessed with worldmet

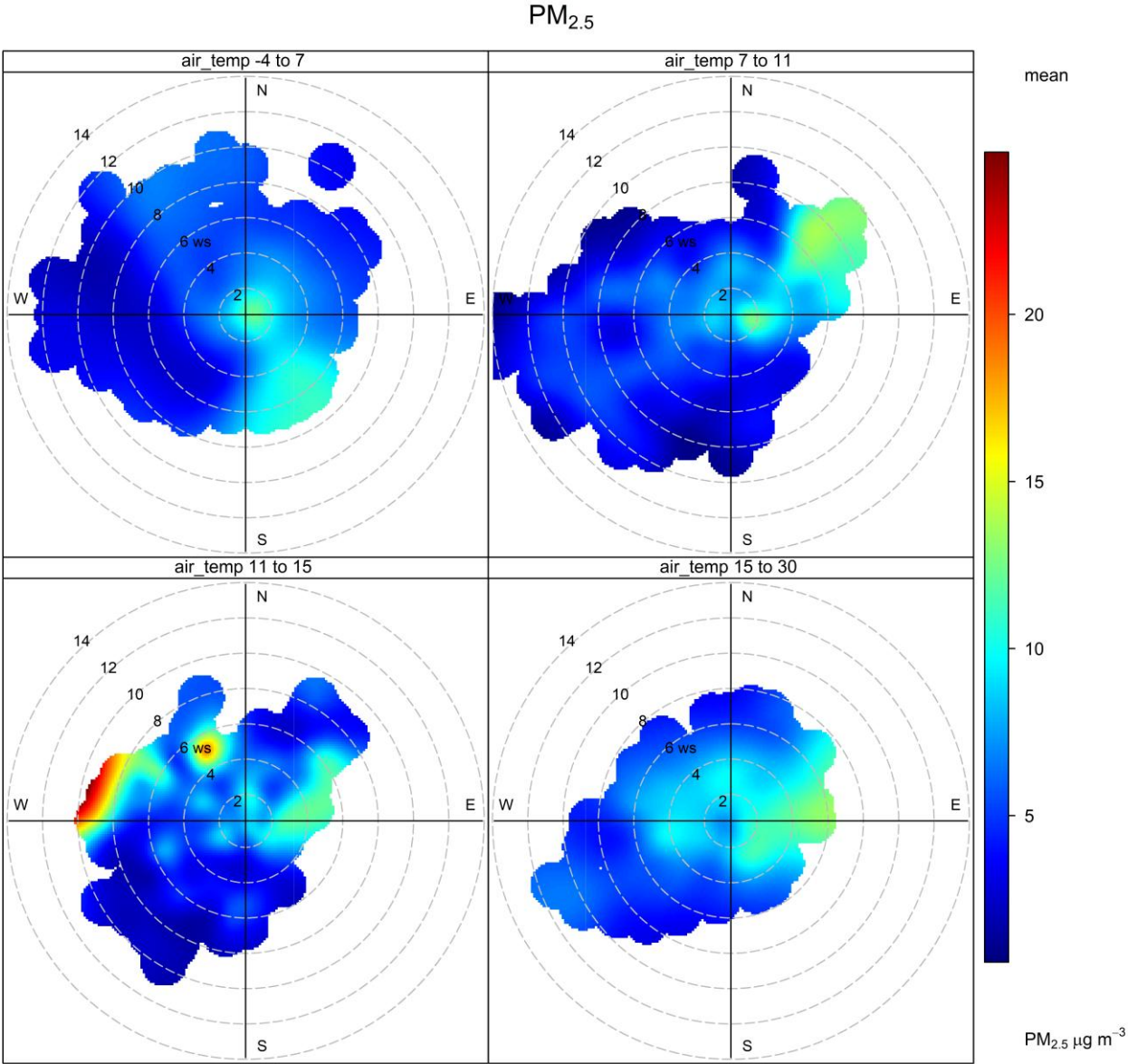


DARLEY AVE

PM2.5

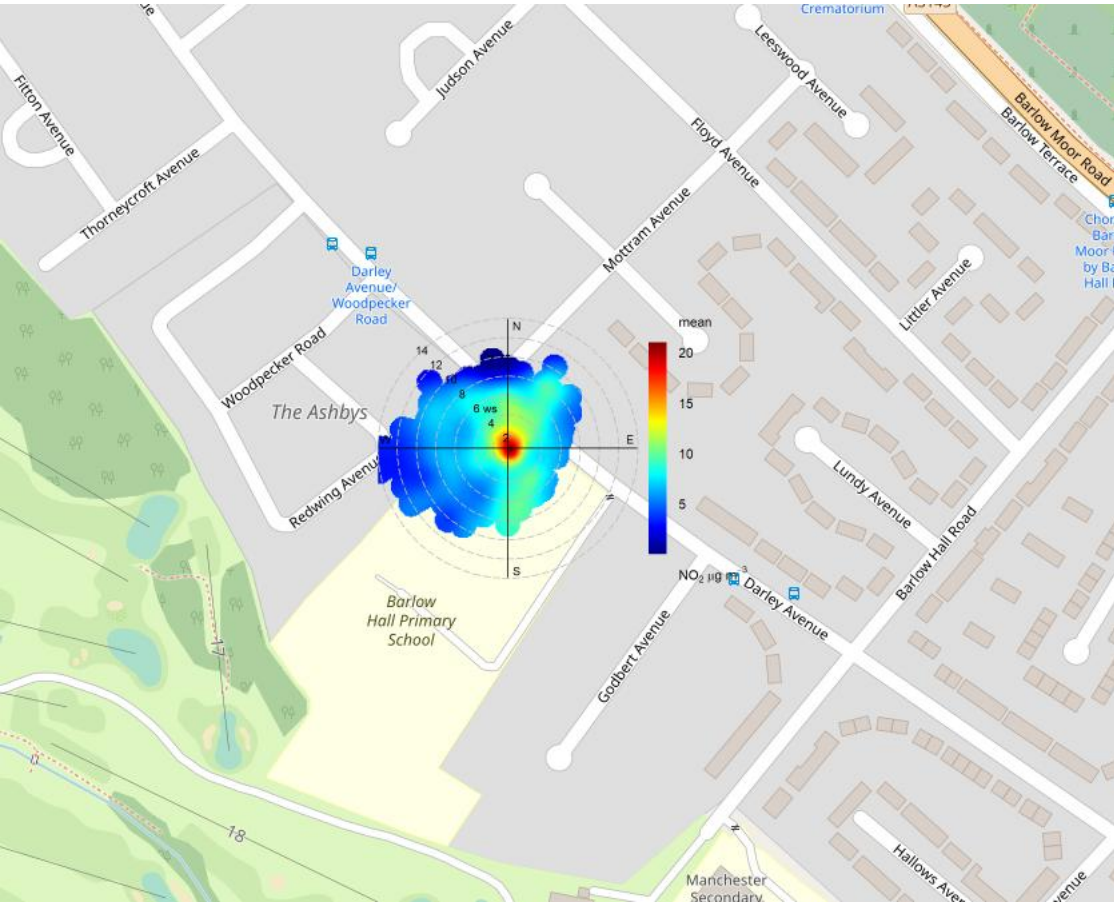


Source: Google Street View

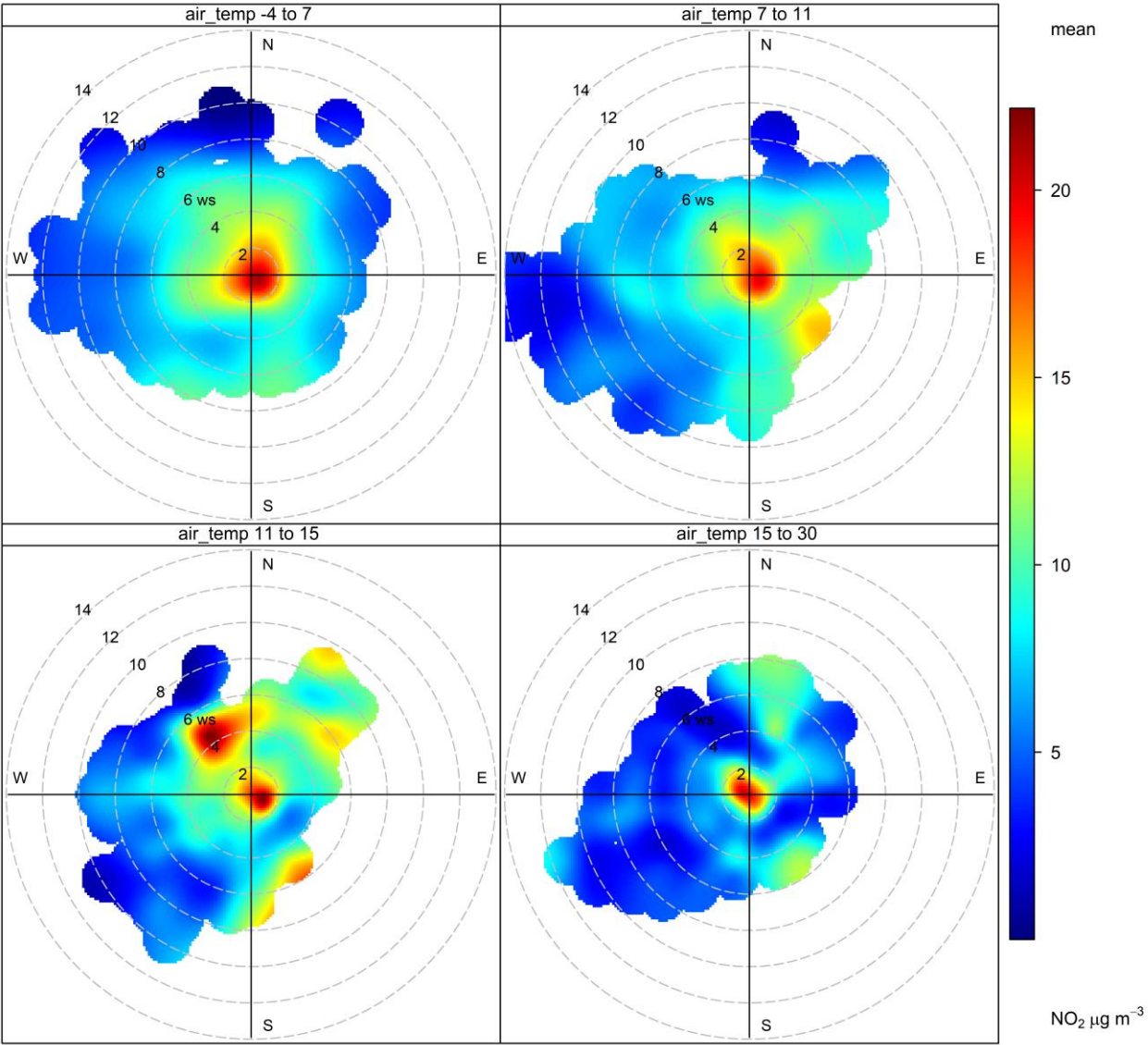


DARLEY AVE

NO₂

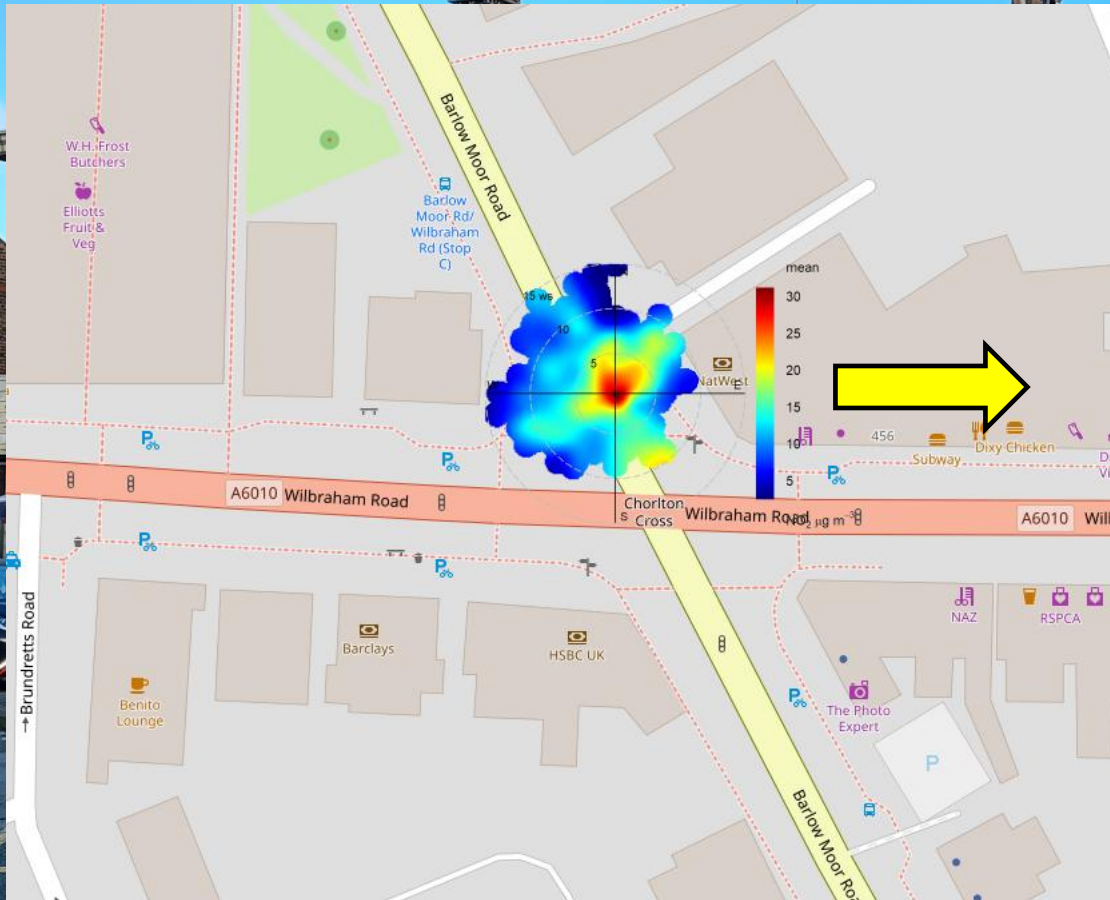


NO₂



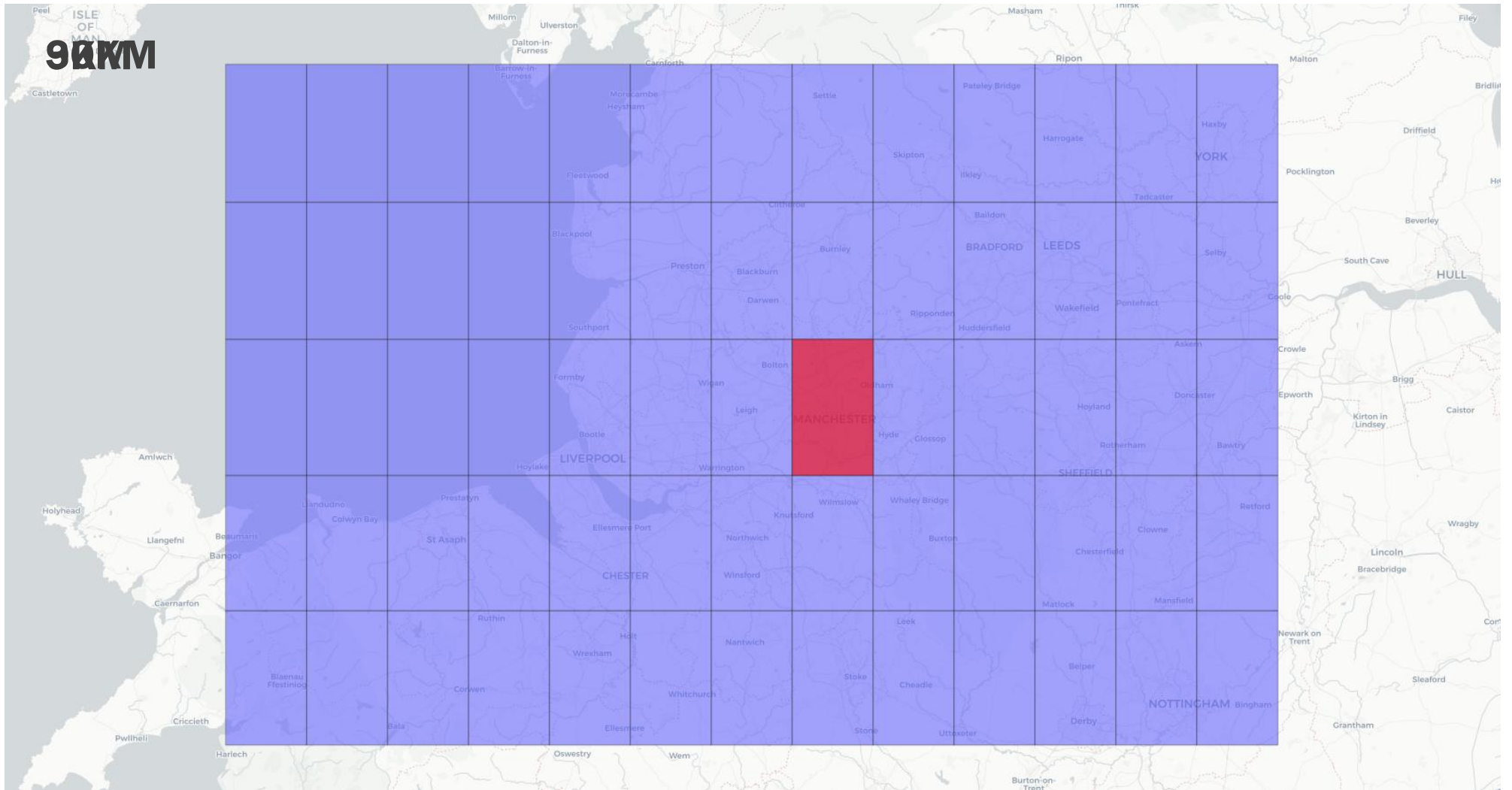
FOUR BANKS

NO₂



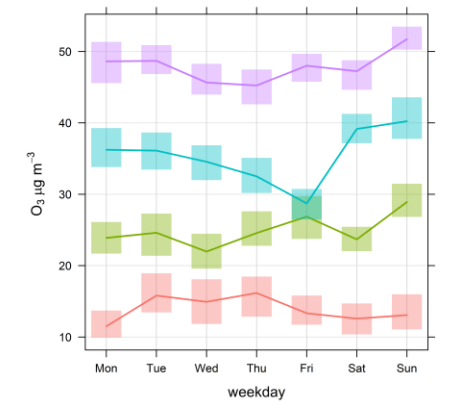
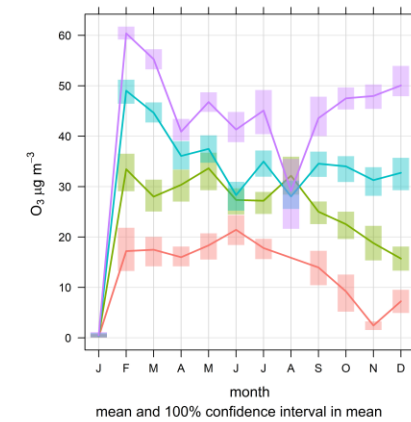
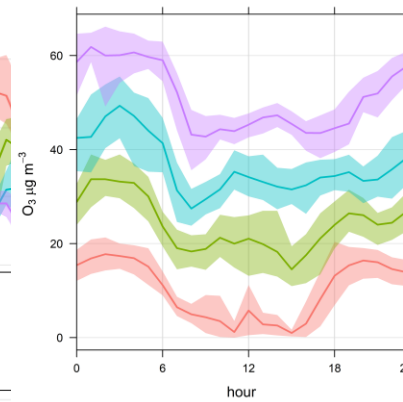
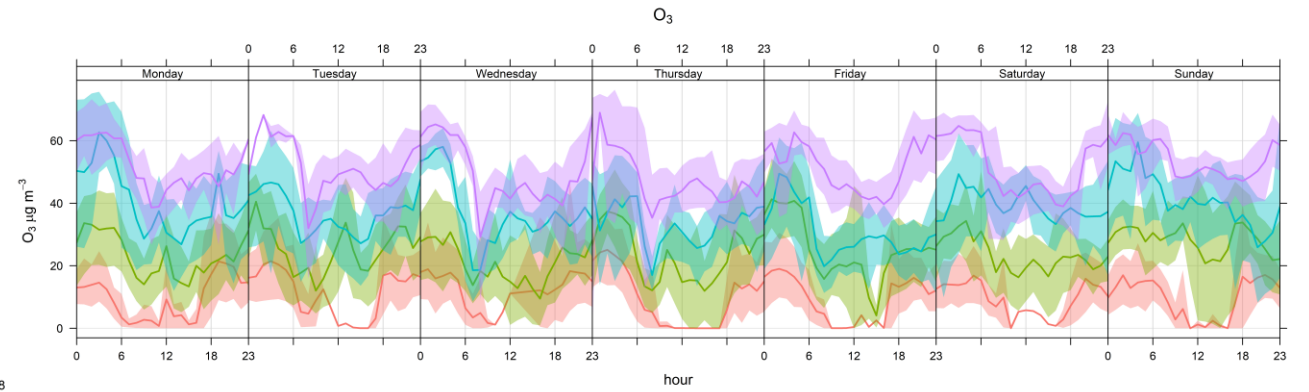
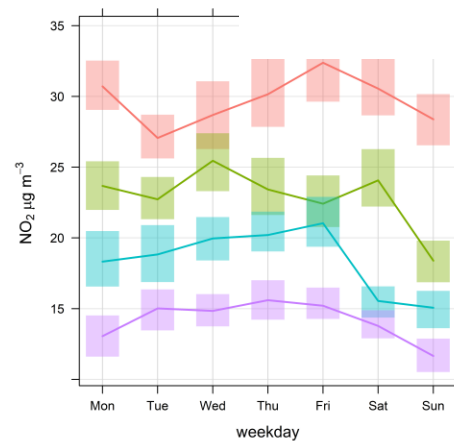
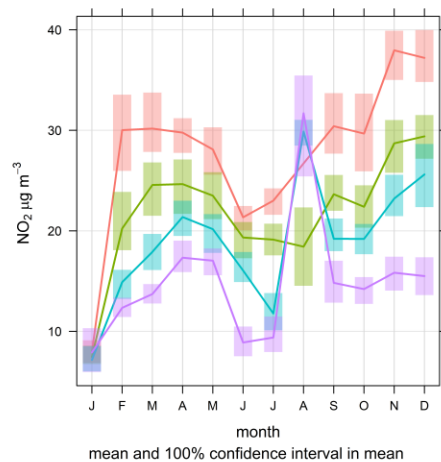
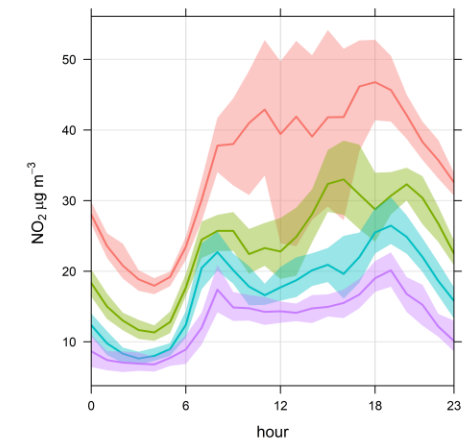
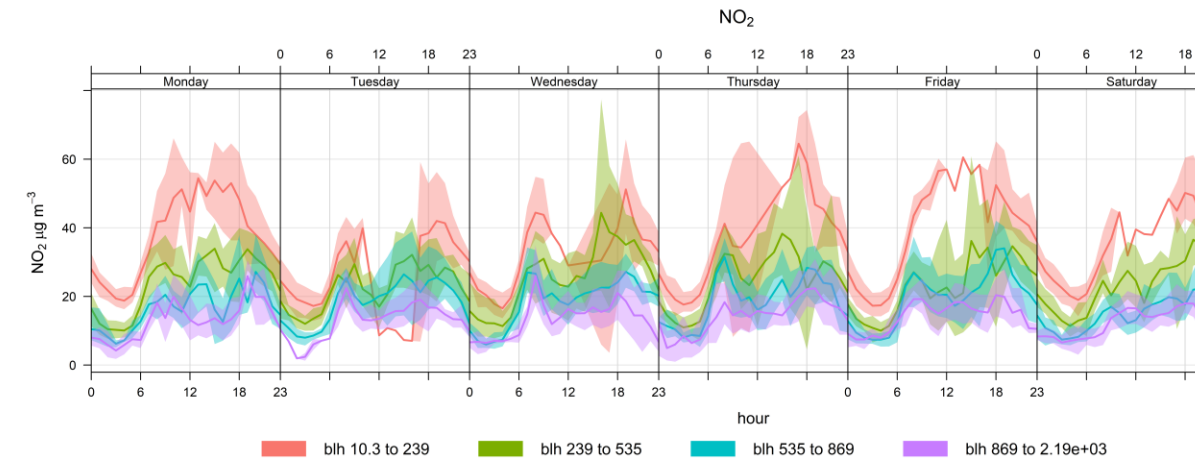
METEO USED FOR BLH & IRRADIATION

- ECMWF reanalysis
- 9km used for 'solar surface downward radiation': the radiation that hits the earth's surface
- 30km used for atmospheric boundary layer



FOUR BANKS

NO₂ & O₃



- Effect of boundary layer opposite for NO₂ and O₃

SANDY LANE

NO₂

