

A UK Air Quality Reanalysis

Eleanor Smith

eleanor.smith@metoffice.gov.uk



A reanalysis of atmospheric composition over the UK

What

A simulation of the past which uses observational data (from the past) to constrain the model

This gives an improved recreation of past reality across the model domain

When

For a ~15 year period initially, starting from 2003

More years will be added to the dataset as a rolling archive

Why

Air quality model and measurement data is often temporally or spatially limited (or both) or inconsistent over long time periods, which limits long term assessments of air quality and health impacts

The reanalysis simulations use Air Quality in the Unified Model (AQUM) in a similar set up to the operational forecasts

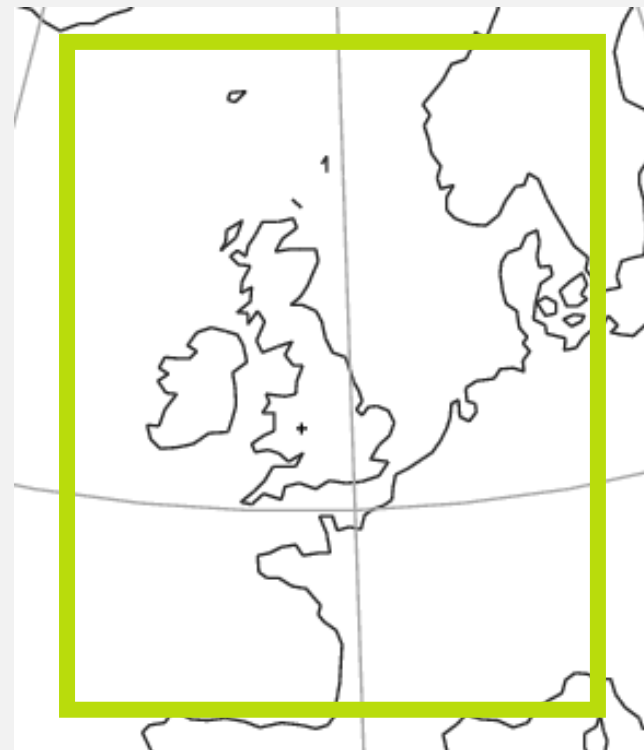
0.11°
(~12 km)
horizontal
resolution

UKCA
Regional
Air Quality
chemical
scheme

Simulation
start time
00Z,
forecasts run
for 24 hours

63 model
levels
(from the
surface up
to ~40 km)

CLASSIC
aerosol
scheme



Savage et al. 2013, <https://doi.org/10.5194/gmd-6-353-2013>




Emissions

Anthropogenic
CAMS-REG-AP

 0.05° x 0.1°
 Europe
 2000 - 2020



Biomass Burning
GFAS

 0.1°
 Global
 2003 - Present



Biogenic
CAMS-GLOB-BIO






 0.25°
 Global
 2000 - 2020

<https://eccad3.sedoo.fr/#CAMS-REG-AP>
<https://www.ecmwf.int/en/forecasts/dataset/global-fire-assimilation-system>
<https://eccad3.sedoo.fr/#CAMS-GLOB-BIO>


Boundary Conditions

Meteorology
ERA5



 0.25°
 Global
 1950 - Present

Chemical Composition
EAC4

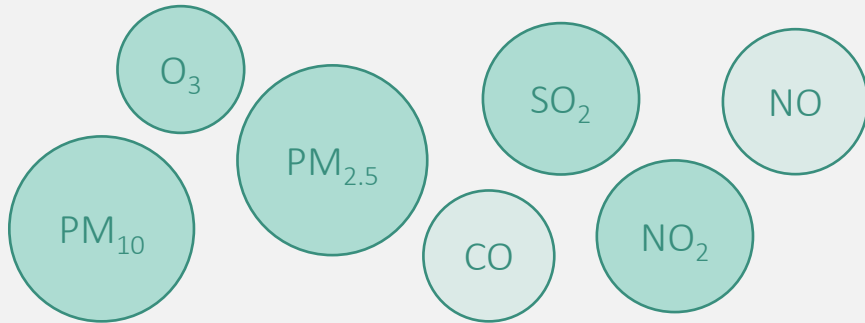
 0.75°
 Global
 2003 - Present



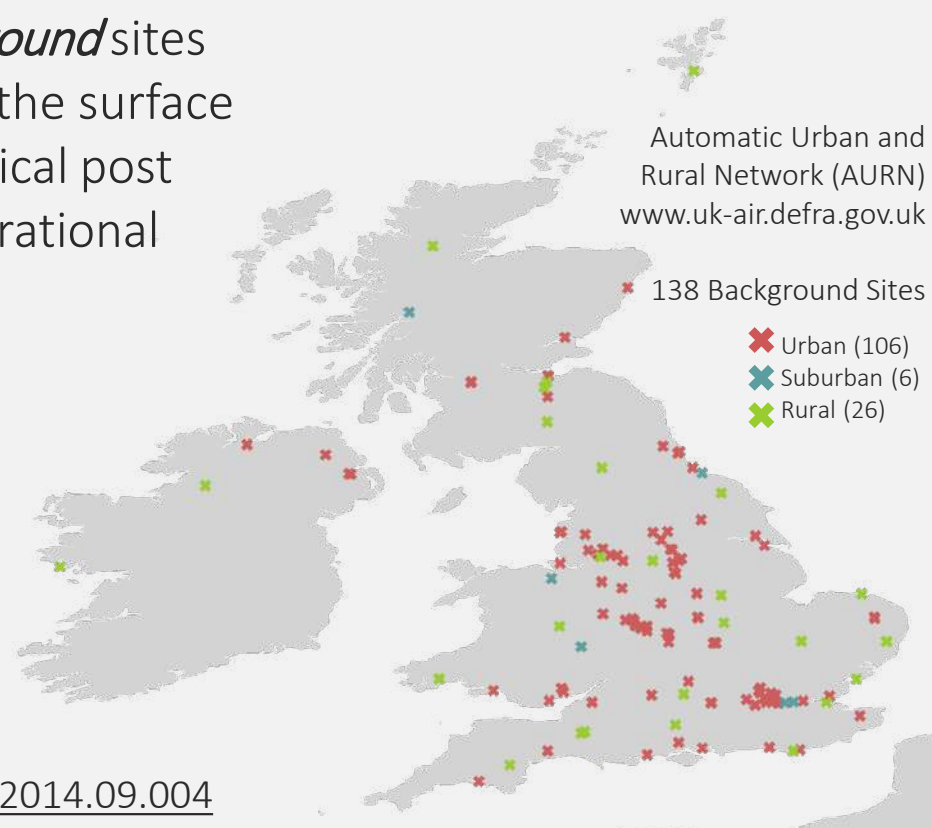
<https://www.ecmwf.int/en/forecasts/dataset/ecmwf-reanalysis-v5>
<https://www.ecmwf.int/en/forecasts/dataset/cams-global-reanalysis>

Measurements of air pollution at *background* sites across the UK will be used to bias correct the surface level model data using the same statistical post processing method applied to the operational forecasts.

The bias correction will be applied to ...

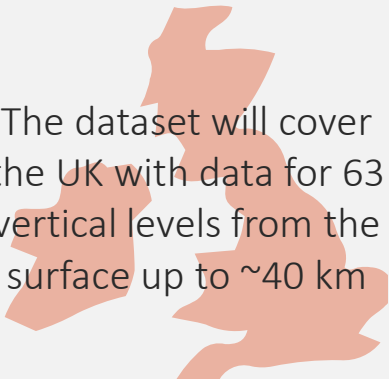


Neal et al. 2014, <https://doi.org/10.1016/j.atmosenv.2014.09.004>

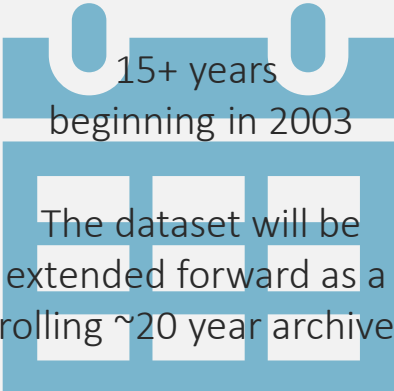


Things that will be included in the data files ...

- ✓ Ozone (O₃)
- ✓ Nitric Oxide (NO)
- ✓ Nitrogen Dioxide (NO₂)
- ✓ Sulphur Dioxide (SO₂)
- ✓ Carbon Monoxide (CO)
- ✓ Ammonia (NH₃)
- ✓ Methane (CH₄)
- ✓ Non-Methane Volatile Organic Compounds (NMVOCs)
- ✓ PM_{2.5}] *(Total Concentration and contributions from Organic Carbon, Black Carbon, Biomass Burning, Sulphate, Nitrate, Dust and Secondary Organic Aerosol)*
- ✓ PM₁₀]
- ✓ Bias corrected concentrations of O₃, NO, NO₂, SO₂, CO, PM_{2.5} and PM₁₀ (**surface level only**)
- ✓ Surface Temperature
- ✓ Surface Pressure
- ✓ 1.5 metre Temperature
- ✓ 1.5 metre Relative Humidity
- ✓ 10 metre U and V Wind Components
- ✓ Surface Sensible Heat Flux
- ✓ Total Precipitation
- ✓ Very Low, Low, Medium and High Cloud Amount
- ✓ Temperature
- ✓ Pressure
- ✓ Boundary Layer Depth
- ✓ U, V and W Wind Components




The dataset will cover the UK with data for 63 vertical levels from the surface up to ~40 km



15+ years
beginning in 2003

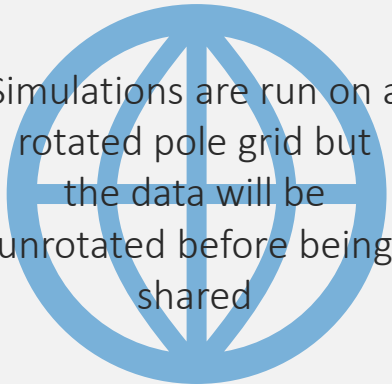
The dataset will be extended forward as a rolling ~20 year archive



The data will be available in NetCDF file format



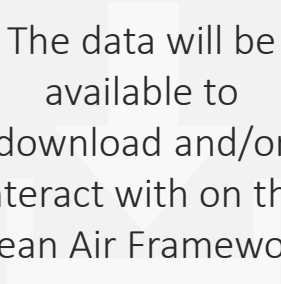
Available
March
2022



Simulations are run on a rotated pole grid but the data will be unrotated before being shared



Data will be available at hourly time resolution



The data will be available to download and/or interact with on the Clean Air Framework



Provide boundary condition information for running local scale models



Look at long term trends in concentrations of different pollutants on different scales (e.g. national, regional, individual)



Investigate how pollutant concentrations compare to limits or targets over extended time periods and examine whether changes in policy might have impacted concentrations



Combine with population information to estimate exposures for health impact studies



Make comparisons with observational data from different platforms

Model Setup

modify the operational forecast model setup to make it suitable for the reanalysis simulations

Observations

retrieve observational data for all available AURN sites for 2003 - 2019

Model Output

select the variables to be output and included in the reanalysis dataset

Production Simulations

run the production simulations for 2003 – 2019 to generate the raw model output data

Data Formatting

convert the data files to NetCDF format on a regular latitude-longitude grid

Data Available

make the data available on the Clean Air Framework



Emissions

select, retrieve and process emission inventory data

Boundary Conditions

select and retrieve meteorology and chemical composition data for boundary condition generation

Model Testing

test the reanalysis model under a range of pollutant conditions and using a range of emission inventories

Post Processing

bias correct the surface level model data using the observational data

Analysis and Publication

analyse the reanalysis data, compare to other atmospheric composition reanalyses and publish the results