# A kilometre-scale air quality model for the UK

As part of the Clean Air SPF, the Met Office is developing a new kilometre-scale air quality model. The Met Office provides the UK national air quality forecast using a numerical model that operates on a 12x12 km2 grid. This is much larger than the typical length scales on which pollutant concentrations vary in the atmosphere and is significantly coarser than the current UK weather prediction model that operates on the kilometre-scale. The aim of this project is to develop a new UK-wide air quality model on a 2.2 km and/or a 1.5 km grid. This will be in line with existing operational Met Office numerical weather prediction models.

Increasing the resolution of the air quality model to the kilometre-scale will:

* better represent atmospheric processes, such as explicitly resolving convection, and better resolve surface features (e.g. orography) that will improve surface interactions (e.g. deposition of pollutants to the surface)
* benefit from emissions datasets that are available at higher resolution, such as the National Atmospheric Emissions Inventory that provides national emissions data at 1x1 km2 resolution
* better resolve pollutant concentration gradients in the rural and urban background environment, particularly important for short-lived pollutants
* provide boundary and initial conditions required by very high-resolution (100-metre scale) urban air quality models.

The emissions of primary pollutants are a primary factor in determining local air quality. The figures below illustrate the improvement in the spatial representation of emissions when using a 2.2 km grid compared with a 12 km grid. The figures show the annual mean emissions of nitric oxide (NO) over the UK and Ireland. The higher-resolution grid better resolves the main road networks, a major source of NO.

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| NO emissions | |
| 2.2 km | 12 km |
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# Applications of the new higher-resolution model

A kilometre-scale air quality model has not been routinely used for the UK and this new capability will be used to answer several open questions:

* what are the impacts of using a convection-permitting model on surface concentrations of pollutants?
* how do we treat emissions (both spatially and temporally) in a higher-resolution model and what are the impacts of resolving finer-scale emissions?
* how do we deal with verification of the model against observations at higher-resolutions?
* what are the costs-benefits of using different spatial resolutions (e.g. 12 km vs 2.2 km vs 1.5 km)?

The model developed in this project will be used to tackle a variety of open scientific questions in air quality as well as inform development of the next-generation Met Office air quality forecast model.

# Early results from the new model configuration

A preliminary configuration of the new model at 2.2 km resolution was run for a single day – 2nd May 2018 – and compared with the 12 km model. The figures below compare the surface daily-mean surface mass fractions of ozone (O3) and nitrogen dioxide (NO2) and demonstrate the first-order effects of increasing the spatial resolution of the model.

For both pollutants, more fine-scale features are apparent in the 2.2 km model, compared with the lower resolution model. The concentration of the short-lived pollutant NO2 is well correlated with its emission (of NO). This illustrative the improved representation of the urban-rural concentration gradient in the higher-resolution model for short-lived pollutants.

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| Ozone (O3) | |
|  |  |
| Nitrogen dioxide (NO2) | |
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